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CONTENTS.

An Asterisk (*) denotes an illustrated article.

EDITORIALS —

Briefly Told 925

The Status of the Gas Rate Contention, New York City—"The Principles and Practice of the Valuation of Gas, Electricity and Water Works for Assessment Purposes"—Notes.

An Ideal Municipal Electric Plant, by Mr. A. D. Adams 926

Experiments on Using Gasoline Gas for Boiler Heating, by Mr. Herman Poole 928

Factory Heating 929

American Competition—No. X.—By Mr. R. W. Hunt 930

Estimation of Benzene Vapor in Gas, by Dr. O. Pfeiffer 932

The Gas Engine in the Foundry, by Mr. Geo. A. True 934

Latent Heat of Evaporation of Liquid Air, by Mr. W. H. Dickerson 935

The Explosive Features of Acetylene 936

The Yield of Centrifugal Fans 936

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 937

Some Lines Concerning "Pointers on Practical Gasfitting"—Betterments at Lebanon, Pa.—Cheaper Gas for Schenectady, N. Y.—An Invitation—The Hawthorne and North Paterson (N. J.) Gas Company—A Story from San Francisco, Cal.—Not So Bad as was Reported—The Catalogue of the Ohio State University—The Sing Sing (N. Y.) Lighting Company—Another Great Man, Toledo, O.—Cheaper Gas for Worcester, Mass.—The Lighting of Certain Royal English Houses—And Other Items.

A Defense Association in the Machinery Trade 938

The Market for Gas Securities 939

BRIEFLY TOLD.

THE STATUS OF THE GAS RATE CONTENTION, NEW YORK CITY.—Those concerned in the gas supply of America have watched with either curiosity or anxiety the course of the parties concerned in the supplying of gas in this city since the famous edicts, reducing the rate from the legal one of $1.10 per 1,000 cubic feet, to rates at the maximum of 65 cents, and to a minimum of 45 or 50 cents, were issued last May. After months of what might fairly be designated guerilla warfare, the open break came officially the first week in May last, when the Consolidated Company announced that, until further notice, its selling rate would be 65 cents per 1,000 cubic feet; the proprietors of the New Amsterdam Company immediately established a rate of 50 cents "or thereabouts," per 1,000; the proprietors of the Mutual Company announced a rate equal to that of the Consolidated Company, and the Standard Company declared that it was prepared "to take care of its consumers." During the summer the fight was waged in bitterness, nor did the contest pale much until October's presentment of the chills of coming winter reddened or yellowed or browned the "leaves that were on the trees." With the end of November one of the combatants (the New Amsterdam Company) announced a restoration of its selling rate to the legal one of $1.10; but the other Companies failed to follow suit. Why the latter are willing to sell gas at 65 cents per 1,000, when they might legally charge for it, until January 1st next, $1.10, and for the year 1900, $1.05 per 1,000, is not for us to say; but the surface outcome of the matter so far seems that gas cannot be sold in New York city for 50 cents per 1,000, and keep its manufacturers whole, in the instance of actual profit and loss account, whereas, on the other hand, gas sold at 65 cents per 1,000 evidently just enables its producers to keep their heads above water. Behind all this miserable contest in gas rates for New York city there undoubtedly is much of personal difference, and the effect of such differences to the gas industry at large would be small did such effect end when the combatants had settled their disputes to their own satisfaction. The pity is, though, that the reflex of the struggle will be felt hereafter by gas men all over the country, who, in explaining the reason why they are obliged to obtain such and such a price for gas in their respective districts, will be met with the rejoinder that gas "is or was" successfully sold in New York city for months at 50 cents or less per 1,000 cubic feet. The JOURNAL does not in any sense wish to figure as taking sides with any of the New York Companies in this contest; but it does say it is a pity that all of those in the compact of September, 1897, did not keep their pledges. Those who failed at the eleventh hour will, we imagine, at best have no greater satisfaction than that which came to the man of strength when he pulled down the temple.

"THE PRINCIPLES AND PRACTICE OF THE VALUATION OF GAS, ELECTRICITY AND WATER WORKS FOR ASSESSMENT PURPOSES."—We are in receipt of a copy of this valuable book, the preparation and completion of which are the work of Messrs. Thomas Newbigging and William Newbigging; and the publisher of which is Mr. Walter King, the Editor of the *Journal of Gas Lighting*, London, England. The book is in its second edition (the first came out in 1891), having been brought up to date last October. It may perhaps be more applicable to England than to this country, owing to the differences over ratings or valuations in the practice as between the States and there; but the fact remains that the book will always be a handy thing to have in one's library. We need hardly say anything to the effect that the Newbiggings are gas men and thorough ones—all the world knows that.

NOTES.—The authorities of Wilkes-Barre, Pa., have arranged with the Wilkes-Barre Gas Company for the lighting of the streets until April 1, 1902, in so far as such lighting is to be performed by gas, under this schedule: 200 lamps or under, $20 per lamp per annum; all lamps in excess of 200, $19 each per annum. We presume that all night and every night lighting is to be done, and that the rate of consumption per hour is 4 feet.——Mr. J. Houston Adams has been appointed receiving teller of the Atlanta (Ga.) Gas Light Company.——The authorities of Wilmington, Del., propose to collect from the proprietors of the Oxy-Hydrogen Gas Company of that city $1,000 of unpaid taxes on the latter's buildings. The Company declines to pay on the ground that the city has prevented it from laying pipes in the streets, thereby render-

ing its manufacturing plant useless.——Mr. W. A. McEwen, Treasurer of the Equitable Illuminating Gas Light Company, of Philadelphia, has notified the shareholders that a semi-annual dividend of 3 per cent. on its shares is payable the 15th inst. ——Mr. Thomas H. Craven, Jr., formerly with the Municipal Gas Company, of Albany, N. Y., has accepted a responsible position with the Peoples Gas Light and Coke Company, of Chicago.——The *Advertiser*, Boston, Mass., of the 5th inst., said: "The Massachusetts Pipe Line Company made its first delivery of gas from the works of the United Coke and Gas Company last night, when it sent gas through its mains to the Jamaica Plain Gas Light Company. * * * Within the next three days gas will be delivered to the Brookline Gas Company at the rate of 1,000,000 cubic feet per day, and this amount will be gradually increased within two weeks to 2,500,000 cubic feet per day, which is the present output of the Brookline Company."——Mr. Francis S. McIlhenny, of Philadelphia, and his associates, have purchased the plant and properties of the Pottstown (Pa.) Gas Company, which concern will in due time be succeeded by an operating corporation to be known as the Peoples Gas Company. In the latter Mr. Francis S. McIlhenny will be President; Mr. W. H. Smith will be Treasurer; and Mr. J. S. Bahr will act as Secretary. Accounts will be collected on the monthly system; heretofore quarterly collections have ruled. Many betterments are proposed for the plant next season.——A correspondent in Indianapolis, Ind., writing under date of the 5th inst., says that on November 29th Judge Carter, in denying a mandamus to compel the Consumers Gas Company (natural gas), of this city, to connect a newly-built house, owned by Mrs. A. E. Wood, with its mains and supply fuel gas for heating and cooking purposes, handed down a decision which, in view of the pending litigation between the city and the Indianapolis Gas Company, may be said to be significant and important. Judge Carter held that the Company had shown its inability to comply with the demands as set out in the complaint. If this, on the other hand, had not been shown, he said, the fact could be proven on the final trial of the cause. The court stated the question of the Company's liability to dig additional wells and lay additional pipe lines would not be considered in his decision, for the reason that this matter would of necessity be tried upon final hearing. After referring to the plaintiff's contention that the Company had no right to discriminate between different consumers or citizens who might demand the gas, and so long as it has any gas whatever must distribute it equally between all citizens on demand, the court said: Natural gas is a commodity just as much as coal, petroleum or ore. Until it is withdrawn it belongs to the owner of the land underneath which it lies, but the instant it is withdrawn through the wells into the Company's mains it belongs to the Company, and is the subject of sale just the same as is coal or coal oil, except in the case of gas, because it must be transported through pipes laid in the streets, the Company has no choice as to the persons to whom it will sell. There are always two ways in which gas is sold and delivered: One is by measurement, at so much per 1,000 cubic feet; the other is at a certain price per stove, grate or furnace supplied. When the question is stripped of its covering and laid bare, it is found to be in a very narrow compass. The situation is this: The defendant is a corporation engaged in transporting and selling natural gas; its supply is limited. Suppose it to be 100,000,000 cubic feet per day. The Company, in accordance with law, has received all applicants and made contracts with them until it has found that to supply its then customers it will take over 100,000,000 cubic feet per day. Under such circumstances, how much gas has such Company to sell to new customers? Every foot that it can transport to this city has been sold and paid for in advance. What right, then, has the Company to sell this same gas to other applicants and receive pay for it again? If the Company is compelled to keep on taking new consumers after its capacity has been exhausted, then, under the system in vogue, it is easily possible for a natural gas company to sell and receive pay in advance at full price for double the quantity of gas it is possible for it to transport and supply to its customers, and the service would be insufficient and unsatisfactory to all. Shall the courts be put in the attitude of not merely permitting or enabling but actually compelling the Company, by way of mandamus, to do this thing? Under the facts stated in the return, I think an inability on the defendant's part to perform the acts sought to be compelled is fully shown, and for the purpose of the demurrer these facts are admitted to be true. If not true, then the falsity can be shown on the final hearing. Whether or not some more favorable result would be worked out for new consumers under the relations which would obtain between the Company and its patrons, under some other method of selling the gas, is a question upon which I express no opinion, as that question is not involved in the propositions submitted to me."

An Ideal Municipal Electric Plant.

[By Mr. Alton D. Adams, C.E., in *Municipal Engineering*.]

The idea of municipal ownership is being persistently brought to the attention of city officials and the people at large. In cases where municipal ownership is not desired, the first cost and subsequent operating expenses of plants erected especially for city lighting must usually have a direct bearing on its contract price, and be, therefore, of general interest. An ideal plant for municipal lighting, whether owned by the city or other interests, may be fairly said to be one offering the best combination as to first cost, operating expenses, reliability and safety to life and property. The degree in which these several requirements can be met is best understood through consideration of the required service. In some small towns the public electric lamps are entirely of either the arc or the incandescent variety, but in most cities the demand includes light of both kinds. The ordinary equipment of a plant for municipal lighting, of both the arc and incandescent varieties, usually includes dynamos of quite different characteristics.

For the arc lighting the series wound arc machines are mostly employed, in sizes of not more than about 65 lamps capacity, though dynamos competent to operate about 125 lamps have been introduced to a limited extent. As the strongest arc lamps in common use, those of nominal 2,000 candle power, require only about 500 watts each in operation, the output of a dynamo to supply 65 of these lamps is only $65 \times 500 = 32{,}500$ watts, or a little more than 40 electrical horse power. A large part of public lighting is done with arc dynamos of only 30 or 50 lamp capacities, and correspondingly smaller power arc lamps supplied from these machines are all connected in series or one after the other on what may be regarded as a single wire that runs from one pole of the machine to the other. On this system the necessary electric pressure, about 50 volts for each lamp, is added to that of all the other lamps on the circuit and the practical working pressures for this class of service limit the capacities of arc dynamos to the small outputs above named.

The small size of arc dynamos makes quite a number necessary in plants of even moderate capacity, and this leads to several simple engines for individual driving, or else to one or more larger engines and long countershafts. The incandescent lamps for public lighting are usually operated from alternating current generators, with transformers. These generators may be of any desired capacity, and if the load of incandescent lamps is alone great enough, may be driven direct by one or more large economical engines. The use of transformers and the necessary secondary wiring involve a large first cost, constant loss of power and an undesirable complication of the system. In some cases the incandescent lamps are operated in series directly from the alternating generators, but this is an unsatisfactory practice for several reasons. In the first place, a break at any point in a line puts out all the lamps on it, as in the case of series arcs; but with incandescent lamps breaks are much more frequent, as they may result from the destruction of a single filament. There are several so-called automatic devices that are presumed to close the circuit when the filament of a lamp gives out, but their action is by no means certain. A more serious objection to the use of incandescent lamps in series of large numbers each is the fact that even the best lamps do not reach their proper candle power on exactly the same amount of current, nor do they change as to current requirement to the same extent as they grow older. A result of this difference in lamps is that, with series operation, some lamps are sure to give less and others more light than they ought, consume unequal amounts of energy and have a very unequal life. The electric pressure for each arc can be adjusted at the lamp, but the proper pressure for each incandescent lamp and its suitable current are inherent in the filament. In series operation all lamps must take exactly the same current, whatever their differences, while the pressure will vary at each, though all are intended for the same volts.

The usual public lighting equipment includes, therefore, at the station, a greater or less number of small dynamo machines, varying among themselves as to both capacity and the kind of load they are adapted to operate. One set of these dynamos may be operating at a small fraction of the total capacity, but it can in no case be shifted onto the other set. To drive these small and diverse machines, their engines must frequently be operated at low stages of load, since it will be practically impossible to concentrate the loads on just engines enough to carry them at any one time.

A number of small machines, usually of the belt-driven type, in the case of arc lighting, necessarily require a much greater station area than would an equivalent capacity in large direct connected units. As engines on light loads have a notoriously large steam consumption per

unit of output, the ordinary station equipment requires much more coal per horse power hour developed than would be the case in a plant where the engines in use at any one time operated at nearly maximum capacity. The belt driving of arc machines from long and heavy shafting not infrequently involves a large and nearly constant loss of power, since the shafting must operate whether one or all of the dynamos are in use. Electric generators and engines require attention in proportion to their numbers rather than according to their capacity, and the average city lighting plant is, therefore, subject to a comparatively large labor charge.

Several small dynamos of any type usually cost more than one or two larger ones of equivalent output, and series arc machines come higher per unit of output than do those of the constant pressure variety.

As both arc and incandescent lamps are frequently required in the same part of a city, for public lighting, the supply of these lamps from independent systems involves two sets of wires over the territory to be served, at a greater construction cost than would be necessary with only one set of wires carrying current at an equal pressure.

A fact to the disadvantage of series distribution is that the rate at which energy is lost in the line remains constant for all loads and so becomes quite a serious item on fractions of the full output. Take the case of an arc lamp line, designed for a loss of 10 per cent. of its load at full output. If the load is reduced to one-half or one-quarter the full amount the per cent. of loss rises to twenty and forty respectively. The common operation of alternating current dynamos at pressures of 1,000 and 2,000 volts make it practical to keep the weight of copper in lines at a comparatively low figure, but some extra expense is involved in the proper insulation of these high pressures, particularly that of 2,000 volts. More or less of the advantage gained by the high pressures of the primary alternating current line is offset by the extent and weight of secondary wiring which operates at low pressure and must frequently extend over considerable distances. The transformer loss is too large to be neglected, and it becomes more marked as the sizes used grow smaller, so that the disadvantages of many and small transformers should be weighed against the cost and operative losses in comparatively long secondary lines. The cost of transformers must, of course, be added to that of generators, of which it may be taken at 75 per cent.

Public arc and incandescent lighting, as most commonly carried out, requires a comparatively large station area and an expensive generating equipment. It involves a large fuel expense and labor charge per unit of station output, and a low distribution efficiency in the series lines for loads much below the maximum.

The machinery and methods for street lighting have changed but little during the past few years, and have not kept pace with improvements in the electric arts, save in a few cases. An ideal municipal electric plant at this time is one in which the latest improvements in equipment and methods are made to contribute so far as possible to a reduction in the first cost, operating losses, labor charges, uncertainties and dangers of present installations, while maintaining or improving the quality of the service. That methods and equipment ready at hand will accomplish all of these desirable results may seem improbable, but the effort here is to point out that such is the case. Consuming devices regulate, to an extent that is not always appreciated, the entire character and operation of electric plants.

The older forms of arc lamps, fitted only to operate on constant current circuits, made necessary the series dynamo and system. The low pressures to which incandescent lamps were limited, until within the last two years, caused their operation in series and also the development of the alternating current transformer. Later forms of arc lamps are now to be had that operate as well on constant pressure as do the earlier types on constant current circuits. Improvements in the structure of incandescent lamps have raised their practical pressures to more than 220 volts. These advances with arc and incandescent lamps make practical a revolution in the design of plants for municipal lighting.

The constant pressure type of arc lamp makes it possible to do away entirely, in many cases, with the small high pressure series arc dynamo and use instead constant pressure machines of any desired capacity. Incandescent lamps of 220 volts insure so wide an area of economical distribution, direct from dynamo to lamp, that in most instances alternating current generators and transformers are no longer necessary.

With arc lamps for constant pressure circuits and incandescent lamps of sufficiently high pressure for the necessary economy in copper, it is at once easy to supply both kinds of service from the same lines and machines. This practice enables any dynamo in the station to supply any part of the load within its capacity. The total number of generators and engines may be so selected that the output at all times may be near the full capacity of those in use.

Two or more large generators, directly connected to economical engines, may now be used instead of the more numerous small machines required by the series arc and the transformer systems. The space required by this uniform constant pressure equipment, and the necessary labor of attention, are much less than with the old style arrangement. Reliability of operation is greater because, in case of trouble with one dynamo or engine, any of the others can do its work. The limit imposed on the size of series arc machines no longer holds with constant pressure units, since in this latter case increase of capacity only involves a greater flow of current, and it is practical to increase the ampere factor to any desired extent, though the volts at which a direct current machine, or a series arc line, may satisfactorily operate are soon reached.

A street lighting plant supplying both arc and incandescent lamps from the same machines requires but one system of outside lines, and from these either or both kinds of service may be taken at any point.

Like many other improvements, electric lighting has an element of danger in it which, while it should not be made the basis of unreasonable attacks, ought to be kept as small as practical. The use of the constant pressure, direct system of supply between dynamos and the arc and incandescent lamps involves electric pressure so low that only under very exceptional circumstances do they become a serious menace to life. The too frequent accounts of fatalities on high pressure arc lines certainly indicate a very real danger that it is well, if practical, to avoid.

A station for the supply of arc and incandescent lamps from the same machines and lines should be operated at from about 460 to 500 volts pressure, according to the length and necessary loss in the lines. The incandescent lamps will require about 440 volts at their terminals, and the station pressure must be greater than this amount by the drop in conductors at maximum load.

If a part of the incandescent lamp capacity is to be employed for interior lighting, it will usually be desirable to have each lamp independent, and in that case the three-wire system, with 220 volts between each outside wire and the third or neutral, at the lamps, should be employed. Where only street lighting is desired, the third wire may be dispensed with and incandescent lamps connected in series of two each to the 440 volt mains, as it is of but little moment that two lamps must burn or go out at the same time, and with only two lamps in a series there is but slight effect on the quality of service. Open arc lamps require from 45 to 50 volts each, and inclosed arcs about 80 volts.

Enough arc lamps of the kind selected should be put in series with each other to make up the line pressure less from 10 to 20 per cent., this fraction of the total voltage being consumed in a resistance placed in each series of lamps. On this plan eight or nine open arc lamps may be placed in a series, and then connected to the 440 volt mains, or a series of four or five inclosed arcs may be used in the same way. If some of the arc lamps are wanted for general interior use, it may be desirable to introduce the third wire, as for incandescent lamps, and the inclosed arcs may then be connected in series of two each.

It will be found desirable in most cases to use the inclosed arc, as with it a pair of carbons burn 15 to 20 times as long as in the open type. The full pressure of constant voltage mains is available for incandescent lamps, but the 10 to 20 per cent. of dead resistance that must be used in series with arcs represents just so much loss. In constant pressure distribution, however, the line loss, instead of being constant, as in the series system, varies with the square of the load. If the loss at maximum load is 10 per cent., at half load it will be only 2.5 per cent. of the maximum load, instead of 10 per cent., as in the series system under the same conditions. The efficiency of series dynamos may be taken at about 10 per cent. less than that of constant pressure machines for the same work, and the series dynamo falls rapidly in efficiency as its load decreases, because its internal losses, like those of its line, are nearly constant. The increased efficiencies of dynamos and line in constant pressure distribution more than offset the losses in the dead resistance with arc lamps. The lower pressures necessary in the constant pressure system tend to increase the cost and weight of conductors, but this is offset by the less expensive insulation necessary, and by the absence of transformers for the incandescent service.

For the constant pressure system the size and cost of the station are less, the constant labor and fuel charges are less, the first cost of dynamos is less and their depreciation slower than with the combined series arc and alternating transformer equipment, while on the other hand the safety, reliability, flexibility and quality of the entire service are improved.

Experiments on Using Gasoline Gas for Boiler Heating.

[A paper read by MR. HERMAN POOLE, of New York, at the December Meeting of the American Society of Mechanical Engineers.]

Last year I became interested in some experiments where air gas made with gasoline was used. The principal point to be settled was if it could be used to get up steam in a boiler; and, if so, at what cost.

The experiments were made at Philadelphia with a 60-horse power boiler. The details are given below. The results showed that steam could be raised in a boiler with gasoline gas as a fuel, but as compared with coal it was much more costly.

Details of the Apparatus Used.—The boiler used was of the common compound, tubular pattern, made of $\frac{5}{16}$-inch iron, and set in brickwork in the ordinary manner. It was situated in a building separated from the mill proper, and so arranged that it could be entirely cut off from all connection with the other sections of the mill. It was not then in use, and had not been for several months. Previous to beginning the experiments, the flues and fire sheets were thoroughly cleaned.

The dimensions were as follows: Boiler; length, 14 feet, diameter, 42 inches; containing 38 flues, 3 inches in diameter; thickness of iron, $\frac{5}{16}$-inch. Superheater; length, 14 feet; diameter, 36 inches; connections, two in number, being vertical pipes 3 feet 8 inches high and 1 foot in diameter.

The fire sheet was 14 feet long and 5 feet 8 inches wide; top sheet of superheater was 14 feet long by 1 foot 8 inches wide; the bottom sheet being 14 feet long by 6 feet wide. The quantity of water was 1,500 gallons or 12,000 pounds.

Water heating surface of the boiler.....	520 square feet.
" " " superheater.	111 "
Total.....	631 "

At the top of the superheater were two 3-inch safety valves with adjustable blow-off. The boiler was tested for 150 pounds; but when in use the pressure never exceeded 100, and was generally 75 to 80 pounds.

The fireplace was 3 feet 8 inches deep, 5 feet 5 inches wide, 16 inches high at the front, and 5½ inches from top of bridge wall to boiler. The grate area was a fraction less than 20 square feet. The grate bars were of the ordinary cast iron pattern running from the doors back to the bridge.

The front was of cast iron, about ⅝-inch thick, and had openings for the superheater, boiler tubes and the two doors. The opening for the ashpit was a flat arch and had no door. The fire door had small openings in the center, which could be closed at will. For the first experiment this opening was bricked up tight. It was afterwards opened and remained so. The brickwork enclosed the boiler on all sides except the front. It was 18 inches thick, and in very good condition, no leaks or cracks being visible on inspection. The walls were close to the boiler on the sides, and about 24 inches from the boiler at the back. In the side wall of the brickwork, about 4 feet from the rear wall and at convenient height, was placed an opening containing an iron pipe. This was for the double purpose of an observation hole and an opening to receive a pyrometer, if deemed advisable.

Leading to the left of the boiler, at the rear end of the brick wall, was the flue to the chimney. This flue was 24 inches square inside, and was furnished with a square, cast iron damper suspended near the chimney by a balanced cord and moving easily up and down. An opening was made in the top of the flue 21½ inches from the damper to admit the thermometer well. This consisted of a 2-inch pipe, 18 inches long, closed at the lower end and open at the upper one. It was to be filled with paraffine wax in which would be placed the thermometer to register the temperature of the water gases. The flue was about 5 feet long, and emptied into the chimney, 2 feet 2 inches square and 65 feet high. It had an iron door about 15 inches square at the base for cleaning.

The gas machine was built especially for these experiments, and consisted of a carburetting cylinder, a mixing cylinder, and a generating cylinder. The carburetting cylinder contained an arrangement for saturating the air with the gasoline, and had a false bottom containing a steam heater to assist in the vaporization. The mixing cylinder was simply to add more air to the mixed gases from the other two. The generating cylinder contained dilute sulphuric acid acting on zinc and generating hydrogen. By our method of working the air was pumped into the generator and the carburettor, and then these two different kinds of air were mixed with more air in the mixer and passed on to the burner. The quantity of hydrogen generated in these experiments was so small that it had no influence on the results obtained, the gas burned being substantially a gasoline saturated air.

In the first experiment the air could not be called saturated, but was more properly a gasoline vapor carrying some air. In the other two the proportion of air was much greater, and more as it should be for good combustion. The carburetting liquid used was 88° gasoline. It was contained in a barrel set up on a staging in the yard some 10 feet away from the machine. The barrel was connected with the machine by means of a ½-inch gas pipe having two stopcocks

For the first experiment the blower used was a small Westinghouse, connected directly to a small 10 gallon kitchen range boiler, serving as a reservoir to equalize the pressure. From this it was connected to the gas machine through a ½ inch pipe, and also by a side opening to the burner under the boiler. This blower was supplemented later by a 16-inch rotary fan blower and by a No. 2 P. H. & F. M. Roots blower. When the rotary blower was used it was connected with the burner direct to supply air to the mixer. When the Roots blower was used the reservoir was dispensed with, and the blower was connected direct to the machine and the burner, a blow-off opening being provided to relieve pressure when necessary.

The first burner used was made of a piece of 5 inch gas pipe, 5 feet long, having ¼-inch holes 6 inches apart along its length. In these holes were screwed 6-inch pieces of ½ inch pipe, with the free ends pounded down so as to make a flat tip, the opening in some cases being only $\frac{1}{16}$ inch across, in others more, but in none more than ¼ inch. This burner was placed in the fireplace just inside the door openings running lengthwise of the boiler front, the holes and jets looking backward and a little inclined above the horizontal. The space under the pipe was filled with fireclay and brick. The pipes rested on firebrick, and the whole was partially inclosed by piling loose brick over it. One end of the large pipe passed out through the brickwork of the boiler, and was connected with the gas machine by means of a pipe having a stopcock just outside the brickwork, and with the blower by means of a separate pipe which also carried a valve. The gas supply pipe was 1 inch in diameter, and passed into the large pipe some 8 or 10 inches, opening just behind the first jet in the fireplace. At first the pipe was used with the full opening. Afterwards the opening was reduced to about one-half.

The second burner used was made from the one just mentioned by removing the jets, increasing the size of the holes to ¼ inch, and running the gas supply pipe the whole length of the large pipe, making openings and jets from it to the holes of the large pipe into which they opened just inside the large pipe. The connections outside the boiler were changed so as to connect with the gas machine direct as before, and with the blower for an air supply by means of a 2 inch pipe. This pipe was supplied with cocks for regulating the air supply, both to the gas machine and to the burner. A blow-off was also placed on the main line to relieve pressure if necessary.

Both burners were covered with a few firebrick placed about 1 inch apart. With the first burner this arrangement was maintained throughout the trial; with the second one it was kept only during the first one-half of the time, as the burner became so hot that softening was feared. The bricks were then removed, part of them being taken out and pushed back.

THE EXPERIMENTS.

Experiment No. 1.—The first experiment was made April 12, 1898. The boiler and chimney were cold, and had not been used for several months. The gas was turned on about noon, and, after several extinguishings and relightings, was finally lighted at about 2:30 P.M., and allowed to burn to ascertain if the water could be heated, no account being taken of the quantity of material used. The combustion was very poor, the gas being too rich in hydrocarbon, large quantities of carbon passing away unconsumed, as was shown by the dense smoke rolling out of the chimney. The damper was full open at the commencement, but was shut down three quarters early in the run.

Air was forced into the burner by means of the blower, but this had the effect of driving the larger portion of the gas to the further half of the burner, thus depriving the left-hand side of the boiler of a large portion of the flame. On the right-hand side the flame passed off in the angle between the boiler and the brickwork, not doing any efficient work until it reached the flues. At no time was the entire under sheet of the boiler covered with flame. Owing to the imperfect combustion the flame burnt smoky, and large quantities of soot were undoubtedly deposited on the boiler. At no time was the supply of air sufficient. After running for three hours and consuming three-fourths of a barrel of gasoline, the boiler showed some 10 pounds steam pressure. As the object was simply to ascertain if steam could be made, and as the construction was decidedly imperfect, no data were taken

of the test. The result was satisfactory for the object in view, but not on general principles. It was proved that the gas had heat, that the heat could be used, and that it could be utilized under a boiler. There were so many drawbacks to a satisfactory result economically that it was not considered.

Experiment No. 2.—This was made April 13, 1898, and while only a short and tentative one and very incomplete, yet developed many more possibilities than were shown at the previous test.

A consultation was had, resulting in a change in the working of the machine, and the consequent production of a much more suitable gas and a much larger and more thorough admixture of air. The burner and other apparatus were the same as before, no change being made in them. The gas was lighted at about noon, and was burnt for some 20 to 25 minutes. The water at the commencement had a temperature of about 100°. The flame was quite satisfactory, both as to quality and quantity, showing perfect combustion with no smoke from the chimney top. Occasional puffs of white mist could be seen, but nothing which could be called smoke. The water in the boiler was heated to boiling, and soon indicated pressure on the gauge. As this was only to determine the effect of the change in the working of the gas machine, and as the result was satisfactory, it was soon discontinued, no further information being possible under the circumstances. After this trial was over a consultation was had, and a number of changes suggested. Among them was the production of a modified burner to consist of the old burner changed in one of two ways. One method suggested was to remove the 5-inch pipe, make some more openings in it on the side opposite those now existing; to screw in pieces of 1-inch pipe on both sides of this piece, making them long enough so that the entire length should be the depth of the fire grate. These small pipes were to have holes on the top for the escape of the gas. The other method was to use the same large pipe, and have it run along in front of the doors, the smaller perforated pipe to run from this back to the depth of the fire surface. Outside, the larger pipe was to be connected with a larger one to serve as a mixer, into which the gas supply pipe should empty, and by its force draw in the requisite air supply previous to reaching the 5 inch pipe. By this arrangement the use of the blower would be obviated, and the gas mixed with air would be delivered at the burner under the least possible pressure. The small Westinghouse blower was to be removed and a larger, positive blower put in its place. The necessary changes in piping were to be made, and a fresh barrel of gasoline obtained.

Experiment No. 3.—This experiment was made on April 21, 1898. The burner had been changed, but not as was expected and as described above; the main difference from the former burner being that the arrangement of gas openings in the air openings did not allow proper mixing before burning; consequently, more air was used than should have been necessary, and a consequent loss of heat resulted in an increased quantity of waste gases to pass off at the chimney. The burner was covered with brick, as before, and the under portion bedded in fireclay and brickbats. The small 2-cylinder blower had been removed and a No. 2 Roots blower substituted for it. The small kitchen boiler as receiver had also been removed. The connections were substantially as before, except that a blow-off had been provided for the blower to use in case too much air was forced into the pipes. A small rotary blower was used also to furnish air to the mixer. The flame produced was generally good, but not regular—the Roots blower being too large to be run at a proper speed; consequently, the air came in puffs. This, while not producing a satisfactory flame, gave a much better one than that used in the first experiment, being well distributed over the bottom of the boiler and causing the firebrick lining of the fireplace to become red hot. But very little smoke escaped at the chimney top, most of the time nothing was visible; at intervals a faint, white mist was to be seen, especially toward the end of the run. This may have been due to condensed moisture. Considering the unsatisfactory form of burner used this result may be called good. The temperature of the water was 50° F. at the commencement; the chimney and all the brick and iron work were of the same temperature. The quantity of water contained in the boiler was 1,500 gallons.

The boiler showed the effects of the fire in a few minutes, and in 1 hour 25 minutes steam was seen to issue from the open try-cock. The fire was kept up, the pressure carried to 60 pounds, and maintained at that point, both safety valves being kept open and blowing all the time. As in the previous experiments, the burner was loosely covered with firebrick during the first part of the test, but the heat was so great locally, from reflection back to the burner, the pipe soon became yellow hot, and to prevent softening the bricks were pushed back out of range of the flame. The damper was wide open at starting, as in the other trials. As soon as combustion and draught were fairly established, it was gradually lowered to about 1-inch opening. The holes in the furnace doors were kept open some time longer, but were finally closed up, all the air being admitted at the burner. The quantity of heat passing off in the waste gases to the chimney was quite small; as at the beginning of the test, full 20 minutes was required to melt the 125° paraffine wax contained in the thermometer well. Definite observations of the temperature were not possible, as the quantity of wax provided for the well was only about one-half the necessary amount, and it could hardly be reached by the thermometer bulb.

The heat passing off by radiation was not excessive, as the brickwork did not become warm to the hand. Of course a larger proportion of heat was used in warming up the bricks than would be with a larger rim. No flame or reflection could be seen through the observation hole at the back of the boiler, showing that nothing but the heated gases reached that portion.

Cost.—The quantity of gasoline used was 35 gallons, costing 10 cents per gallon. This generated 1,000 pounds of steam at 60 pounds pressure, equivalent to 1,211 pounds evaporated from and at 212°.

It was intended to have a full time experiment of 8 to 10 hours, so as to obviate some of the many uncertainties; but this was not carried out, and the paper is presented as simply a contribution to the subject, but not as one settling any important questions.

Summary of Data and Results.

Time of trial	about 2 hours.
Grate surface	3 ft. 8 in. by 5 ft. 5 in., or 19.9 sq. ft. of area.
Water heating surface	520 sq. ft.
Superheating surface	111 sq. ft.
Total	631 sq. ft.
Ratio of water heating to grate surface	26 to 1
Ratio of minimum draught area to grate surface	1 to 12
Steam pressure	60 lbs.
Temperature of air	50°
" boiler room	80°
" steam	292.5°
" feed-water	(none used.)
" waste gases at chimney	(not taken, estimated at 325°)
Fuel used	air-gasoline gas.
Analysis of gas	(not made.)
Quantity of gas used	(not measured.)
Quantity of oil used	35 gallons (estimated.)
Weight of oil	227.5 lbs.
Calorific value per pound	20,000 B. T.
Total weight of water in boiler	12,500 lbs.
Weight of water evaporated	1,000 lbs.

Heat Balance.

Total heat value of 1 pound of oil used, 20,000 B.T.U.

	B.T.U.	Per Cent.
Heat absorbed by boiler	3,483,250	76.5
Loss due to water formed by combustion of hydrogen	385,100	8.5
Loss due to heat in chimney gases	236,600	5.0
Loss due to incomplete combustion	....	....
Loss due to absorption, radiation, etc	445,050	10 0
	4,550,000	100.0

Factory Heating.

It is at this season of the year, says the *Age of Steel*, when the iceman calls for his final settlement and passes out the door with a good-bye till next summer, and turning around comes in at another door disguised with a little coal dust, and asks to be with us through the winter. In other words, with the passing of the iceman comes the more serious problem of keeping comfortably warm through the winter months. There is no doubt but that of late years the problem of keeping the factory warm during the winter has been duly considered by the majority of progressive factory owners, and those who have tried it thoroughly have no doubt found it to pay, but there seem to be many yet who do not seem to seriously consider the warming problem much further than to keep the office comfortable.

If we leave out altogether the humane principle that should induce a man to have his workmen comfortably housed during the winter if possible, we still have plenty of argument in the cause, for it is good business, and an investment in warming apparatus will pay, inasmuch as it insures more work, better work and better humored men all around—an essential feature in the smooth operation of any factory.

Men can do rough labor, and by hustling like fury keep warmed up themselves in tolerably cold weather, but when we come to consider this item in running a factory we find that the rough labor is the cheap work, and that the men who by virtue of their skill in special lines command good wages are the very men who are handicapped in their work when the temperature gets down uncomfortably near the zero point. These are the men whose loss, in time, temper and inability to get satisfactory results out of machines or material, will count up on the financial argument for a heating system for the factory in winter.

As to methods and systems for heating, there is room for argument without end, and if one were to consider them in an abstract sense it might be a toss up to decide, but usually there is some individuality in each factory and its operations that is a factor in reaching a decision, and those contemplating such a departure should study methods with a view to adapting them to their individual requirements, instead of in an abstract way. In competitive essays on house warming we are introduced to some half a dozen systems and combinations, consisting of steam—at high and at low pressure, hot water ditto, hot air and some combinations. Heating with air is given as the oldest method, and its introduction is set by one authority as some time about 1758, or a couple of decades before the origin of steam as an agent for both heat and power, but the historically inclined may have a dim memory of some ancient ruins in which there was evidence of efforts to keep the building warm by having a fire on the outside and an air tunnel running into the house, and this would antedate the accredited introduction by several centuries. It's queer, isn't it, how we take up old ideas and modernize them. But any way, we may wade through the whole file of house warming manuals and not find just what we want for a factory heating system, because there is a wide difference in the requirements, and there is also a lot of wasted heat going out the exhaust at many of our factories that could as well be used at a small outlay in pressure, and no other method of heating should be thought of as long as this exhaust is going to waste. It requires some study, though, and systematic work to handle exhaust steam for the best results with the least additional labor for the engine. In fact, it is a very simple question to handle live steam as compared to it, for in the use of live steam it is easy enough to have branch pipes and valves for regulating the supply to the requirements of each department separately, while in the use of exhaust, when you go to throttling down at any point you are screwing back pressure onto the engine. Suppose, for example, that you start out to heat only one department at first, you pipe with a view to draining back the water and all that, and put a back pressure valve at about 5 pounds on the open air exhaust and send the steam through the heating system. Then, if the other departments are directly above this one, you may continue the system up through the factory and still get very good results. This is by reason of the fact that heat goes up, and though the first department through which the system passes gets the lion's share of the heat it passes from there up and helps in a manner to warm the upper stories. Now, if the factory consists of several wings, and we start in to heat all of them with exhaust we begin to understand the imperfections of the system. If we run a single system the first department will be uncomfortably warm when those on the tail end of the system are still cool, for all the steam that goes throughout the plant must pass through the nearest department first on its journey. To secure a better distribution of the heat it is the usual practice in large plants to compound the system, and to do this and not necessitate an increase in the back pressure requires some care, not only in construction, but also in operation, but it may be done, and where the factory is so large that in very severe weather the exhaust will not supply sufficient heat, it is a very simple matter to supplement it with live steam.

Where the exhaust is required for some special service about the factory other than that of supplying heat for the building, the question simmers down to an issue between live steam and hot air as agents for supplying heat, and where both have to be produced independently it is rather a hard question to decide between the two. There is one thing that must be borne in mind, though, and that is that you have got to use fuel to produce all the heat you send up in the factory, no matter what agent you use—unless it is the exhaust, and in that you simply save what would otherwise go to waste, and saving is making in itself. Even if you draw some of the apparently useless heat from in front of and around the boilers and fan it up through the building, the air blown out will be replaced with cool air, and it all takes up heat from the coal that you think you are using to make steam only. Live steam has one thing in its favor in that it is always so that you can turn it on and have the factory warm before work time in the morning, while with exhaust, and with hot air distributed by fan, unless driven by an independent engine, you have got to wait till the factory starts before you start to warming it up, and there is a period of early morning frostiness. This is a point that might well receive more attention from managers of some plants who may be fooling themselves by thinking they have got the heating question down fine, while in fact they may be running a cold shop at the very time of day when it is most desirable to have it nice and comfortable—the opening hour. If the manager of such a plant will get out and catch the first cars out toward his works on a cold morning like his men do, and then go into the factory with them and shuck himself for work as they do, and come in again at noon and eat lunch with them while the shop is standing and getting so cold that all are shivering, he will likely get some good ideas of just what constitutes a properly warmed factory.

[From *Engineering*.—Continued from page 891.]

American Competition.—No. X.

By Mr. Robert W. Hunt, Chicago.

To indulge in prophecy is very attractive and promotes high personal gratification, but it is also dangerous to the prophet's reputation for acumen, particularly should the augury be put in print.

Some years ago the United States saw a period of low prices, much below any which had ever been thought possible; but they appeared well established, and many seemingly strong arguments were advanced to prove that they must be permanent; in fact, that no one would live to see a return of the higher conditions of but a few years before; it was confidently predicted that 1892 was to be always noted as the year marking the exit of high values. But 1899 is, and 1900 seemingly promises to be, remarkable for prices far beyond those of 1892; and who can tell how long these conditions are to continue?

Therefore, when we discuss American competition, I take it we will do it on the basis preceding 1899, rather than on that of to-day. Not that competition has ceased to exist, in fact quite the contrary; but conditions have changed.

When Sir Lowthian Bell, in 1874, contributed to the Iron and Steel Institute his paper, in which he gave strong reasons why it would ever be impossible for iron to be made more cheaply in the United States than in England, his arguments were based on geographical and physical obstacles which then appeared to be insurmountable; the geographical obstacles remain unchanged, but some of the physical have been greatly altered. The ore beds are no nearer the sea; the coal is as far away from the furnaces, and American labor still demands, and receives, higher pay; but the cost of mining and transporting the ore has been reduced; coal and coke prices have been made less to the consumer, and labor produces more per day per man.

The great intervening distances in America seemed permanently to prevent extreme low costs. But, to my mind, this very difficulty has pushed forward the solution of the problem. Leaving out of consideration the attempt to supply any markets save our own, it became necessary to reduce the cost of transportation; not only the mere expense of hauling and carrying, but also the handling necessary to loading and unloading. Immense and rich iron ore deposits might exist at the head of Lake Superior, but they were of very limited value, with the necessary fuel for smelting something over a thousand miles away, unless ore and coal could be brought together at a sufficiently low cost. Climatic conditions and the increasing market determined that the ore should seek the coal, even though such a course involved the transportation of a greater volume. Naturally the first steps taken were to increase the carrying capacity of the Lake vessels, and to supersede sails by steam. This was followed by a realization of the necessity of saving time and labor in loading and unloading the ships. Here came the most radical departure in Lake transportation. Without this development, the employment of the largest vessels would have failed in its greatest value. But the vessels were not only increased in size; they were improved in arrangement, speed and economy of propulsion.

Hence it was that in the season of 1898 the best boats were enabled to carry ore from the head of Lake Superior to the lower Lake ports, a distance of 1,000 miles, for 60 cents, or 2s. 6d. per gross ton, and return handsome dividends to their owners. As partially explaining how this was possible, we have but to know that a 6,000-ton vessel can be loaded at the up lake docks in six hours and even less, and discharged at the port of destination in twelve hours. Such a ship has to carry back a return cargo of coal; it is transferred to her hold by the car load—each car being bodily lifted and turned upside down over her hatches; in this way a cargo is placed in ten hours. To fully understand these points, I refer my English readers to Messrs. Jeremiah and Archibald

Potter Head's admirable paper read before the Institution of Civil Engineers, February, 1899.

Much of the ore carried at these surprising rates is mined by machinery at a cost of less than 1s. per ton, including all charges for stripping off the surface, etc. Other portions come from underground mining produced at a cost of not over 2s. 6d., and the hardest to mine does not probably cost more than 3s. per ton. When not owned in fee the royalties vary from 1s. to 1s. 6d. per ton. The railroad freight from the mines to the docks, from the pockets of which the ore had been chuted into the vessels amounts to, say, 3s. 4d. per ton. When this ore is met by fuel which had been cheaply mined, coked and hauled, and together mechanically charged into blast furnaces producing from 200 to 700 tons per 24 hours, it is no mystery that the resulting metal should represent a cost far below anything thought possible, not only by Sir Lowthian Bell at the time already named, but by the most sanguine American.

To turn to the Southern States. In many places the ore, coal, and limestone have been developed so closely together that the necessary transportation of the raw materials was a mere bagatelle. But it required years of experience, and some of it very costly experience, paid for not only by American, but also by English capital, to learn the proper methods of selection and treatment of those cheap materials, before success was attained. And there was still the question: When the cheap pig was made, where was the market? Here, again, cheap transportation came in, and it was made possible to find the markets, not only hundreds of miles away in our own country, but also, for much of the products, after being hauled 700 miles by rail, to customers across the ocean. In the discussion of freight rates, mere distance has generally been far from the prime factor. It may be said that while diminution in rates has been going on, it has been at the expense of the investor in the railroad companies. That is true, but without the low rates the business could not have been created, and without business no railroad can exist. Perhaps there were too many railroads; but, again, without them the country could not have been developed. At all events the situation existed, and the problem was to make the traffic pay without increasing the freight costs. This led to the use of heavier engines, and to cars of greater capacity; these, in turn, called for better road beds, which in turn permitted increased speed. So while, as it so often happens, the orginal investors may have suffered, the ultimate result has been eminently successful, not only for freight, but for passenger traffic. When we compare an English goods wagon with an American steel car, carrying 100,000 pounds load, it is easy to understand the difference in freight rates in the two countries. I was told a year ago by a prominent English railway official that his company had thought most seriously of materially increasing the size of their freight cars; observation having convinced them that in that way lay the quickest road toward lower rates. With this in view they consulted their principal shippers—who, I believe, were coal miners—and these unanimously protested, saying: "Don't do it; because, if you do, we will have to alter our sidings, coal shutes, etc., which would cost a lot of money." So the company had to give it up. That did not sound like the answer which an American railroad manager would have been apt to receive from one of his patrons when proposing a scheme to reduce freight rates.

It must be remembered that the United States is a young and still far from a fully developed country. Notwithstanding the tremendous strides which her people have made, there are yet thousands upon thousands of miles of practically unknown, or rather unexplored, territory. We have no reason to assume that another Messabi range is not lying unknown in the Lake Superior region. It may be on the Canadian side of the line, but the waters of the great lakes must float its products to the fuel. There are millions of fertile acres awaiting the husbandman.

As in the past, so in the present, we welcome the peoples of all the earth—objecting a little, perhaps, to the Chinaman—but he is here "alle samee." "Come to us! Become of us!" has been our salutation. Whether the crowds always trooping to our shores be Scandinavians, Germans, Frenchmen, Italians, or Englishmen, makes no difference in either workshop or counting house. Each stands on his merits as a man.

The result has been that while some not very desirable citizens have come to us, thousands of others have been of the best. Another inevitable result has been the mixing of blood; and it has happened that soil and air prove favorable to the development of a fine race—a people to whom the word impossible will disappear from their dictionary. With evidences on all sides that difficulties of nature, and disqualifications of birth and fortune have been overcome—why should not success be his individual portion? In such an atmosphere it is easy to understand how it has been possible to attain results which would at least be much more difficult in most other countries.

Again, in a new country resources are more limited than in a long settled and rich one. This instinctively influences everything. If a railroad is to be built, and the country to support it has to be developed after its construction, it is not surprising that the road bed, stations and general equipment should not be up to the London and Northwestern Railway standard. So, if a frontier man had not a plane, he smoothed the timber for his floor with his axe. And later, if the mechanic had but few tools, he used them for the most varied purposes possible. When he became able to buy more, he wanted them not like his old ones, but ever so much better, and suited to serve more purposes; and if there was not such a one to be found, he designed one which, when invented, the patent laws of his country protected for him. This stimulated all energies. And the fact that pecuniary rewards often came from patents obtained by those inexperienced in the lines of manufacture covered by them, lent increased inducement.

I happen to know that once a supposed improvement in making malleable castings was submitted to the head of the largest and most successful malleable iron company in this country, whose reply to the inventor was, "While your plan seems to be without good patent claims, you have one great point in your favor, and that is that up to this time no one in the malleable iron business has made an invention which has been of any value." But the claim did prove sound, both parties made money and the art was advanced. Now, that was American! If the inventor had been met by the statement that the listener, and his father, and his father's father, had been makers of malleable castings all their lives; that they therefore knew all about the business, and that it was folly to suppose anything could be outside of their knowledge, the applicant would have departed humiliated and discouraged; or, under such conditions, would most likely never have ventured to present his plans.

It is ridiculous to assume that all invention or all progress belongs to this country. We all know better. But I do claim that conditions here are more favorable for both than in older countries. Everything leads towards it. In America, everybody who has self-respect—and therefore the respect of his neighbors—works with hands, or brains, or both. To be an idler condemns him to seek the seclusion of our Eastern cities, and more than likely he cannot stop there, but has to find the first dry land on which to rest, on Transatlantic shores. This high pressure may not tend to personal comfort and easy bodily times, but it does make "things go!" Of course, we will gradually get away from this, but there are many years yet to come before we occupy the social conditions of the older countries. Perhaps I have drifted somewhat away from the strict line of the subject. Needless to say, I should know more about the iron and steel industries than others. It happened to be my fortune to be connected with the first introduction of the Bessemer process into America. We accepted the process surrounded by all of its English and Swedish conditions. But two very bright American engineers—A. L. Holly and Z. S. Durfee—were responsible for its first trials in this country. To speak of the latter first, he quickly saw that the English plan of melting iron in an air furnace was too slow, and so introduced the cupola practice. The former, with his supreme mechanical and metallurgical talents, attacked everything established, and led the onslaught, supported by the men, whom his lovable personalty made devoted to him and the cause; until, instead of Bessemer steel belonging to England, as regarded from tonnage obtained by works of given size, it became an American institution. The new industry could not stop at the production of ingots, but logically had to extend to their further manipulation. So came the Fritz blooming mill and the Hunt-Jones-Suppes rail mill, with many improvements added, and other inventions made, by other engineers.

As we have gone to the old countries for men, so in the past we looked to them for bases on which to found our progress. Perhaps this is to continue. But we will not for years to come be willing to believe that when we receive this, or the other, invention, it has been developed to its fullest extent. Of course, it is now well recognized that one trouble in England is the tyranny of trade prejudice, or, if you please, trade unionism. A man to every machine, and but one machine to a man, and its production under him limited. Well, England will get over that, but only after some more lessons hard to digest. We have troubles from trade unions in this country, but not so bad; and it is, I think, a fact that those giving the most trouble, and doing the most damage to the cause of labor, are members and leaders who are the latest arrivals from the old countries. Capital is largely to blame for labor troubles. Of course, the most ordinary business organization

is a combination of capital; but as this increases, the danger grows that humanitarianism departs. But where do you find less of it than in trade unionism?

To revert to what England must do to meet American competition, may I, in conclusion, relate a personal experience? I visited an English steel works and rail mill, where I was most cordially received, shown every possible attention, and was given all legitimate information. The works were in fine condition, much money had been expended in compounding the engines, etc., and more was being put into an electric plant. After going through the works, the host took me to his private office, and extended more true English hospitality. During the conversation he asked me if it were true that the American rail mills had been making the tremendous product reported. I replied that I did not know what he had read, but that one American mill had produced during the preceding month, 48,000 gross tons of finished product, 43,700 tons of which had been rails, the remainder 4 inch billets. He exclaimed: "Wonderful! What are we to do to meet this?" I replied, "My dear sir, after going through your fine works, in which you are producing some 500 tons per day, and seeing how much pride you take in them, and in what fine condition you have them, it seems brutal to answer you." "No," he said; "tell me—what?" I could but reply, "Throw them away, and put in an American plant, and, when installed, run it."

Just then we were interrupted by the entrance of a man who was presented to me as the engineer of the establishment, and who came in to ask for some information. He was told what I had given as the month's production of an American rail mill, and was asked what he thought of it. With some confusion, and many apologies to me, he said: "I don't believe it." My host exclaimed, "But Mr. Hunt says so!" "Yes, I know," he replied; "but they fooled him, you know. They had more than one mill. You know, Mr. —— that, man and boy, I have been in rolling mills some 35 years, and I know it can't be done!" Of course, I laughed, and he, still confused over having to tell a Yankee, a guest in his employer's house, how he could either stretch things, or else show his gullibility, withdrew.

My host almost fell on my neck in making excuses, but I said: "Not at all, it is all right; your man has helped me to further answer your question. When you build your American mill and try to run it, don't put it in his charge. There must not be any such statement known as 'it can't be done.'"

Estimation of Benzene Vapor in Gas.

By Dr. Otto Pfeiffer, of Magdeburg.

The *Journal of Gas Lighting* recently had the following article on the named subject translated from the *Journal fuer Gasbeleuchtung:*

Volumetric gas analysis approaches, in respect of accuracy, the branches of chemical analysis in which the balance is directly or indirectly used, in so far that constituents of a sample of coal gas, having a volume of 100 c.c., and weighing 0.05 to 0.06 gramme, may be accurately estimated within 0.2 per cent. by volume, which is equivalent to 0.0001 gramme. Unfortunately, however, this statement refers only to the principal constituents of the gas. It applies to the heavy hydrocarbons as a whole; but volumetric gas analysis fails to discriminate between the several groups of these hydrocarbons. But a knowledge of the nature of the heavy hydrocarbons is of the foremost interest to the gas manager, as, though their total quantity is small, their nature has a most important bearing on the fitness of the gas for different uses. Such knowledge would not only enable the illuminating power of the gas to be estimated from analyses, but would afford the data for a more reliable estimation of the calorific value of the gas than the calorimeter gives. In coal gas there are two varieties of heavy hydrocarbons which are of importance—viz., ethylene, which is a gas, and the vapor of benzene, with which are associated higher homologues, or bodies belonging to the same series of hydrocarbons. So far, however, as our knowledge of coal gas indicates, the quantity of these homologues in it falls off, in comparison with the quantity of the primary member of the series, in proportion as the homologue is farther removed from the primary member; and as there is little difference between the properties of contiguous homologues, only an error of no practical significance will be introduced if the heavy hydrocarbons are regarded as consisting merely of ethylene and benzene. More exhaustive classification and distinction of the constituents would be of little service.

The hydrocarbons of the two series known as the benzene and ethylene series differ in properties to a remarkable extent. The illuminating [illegible]e of vapor of benzene is about six times that of an equal volume of ethylene; and its heat of combustion is about 2½ times as great. The importance of distinguishing between these hydrocarbons in an analysis of the gas for the purpose of assessing its value, is therefore very great. The many attempts which have been made to separate ethylene and benzene quantitatively, show that the importance of finding a way of separation has been fully recognized in the past. In the sequel, the means hitherto propounded will be briefly referred to, and a new simplified experimental method, and a method of calculation, will be described.

Bunsen found the contraction due to, and the amount of carbonic acid arising from, the combustion of the heavy hydrocarbons in gas, by observing the differences between the results of the combustion of a portion of the original gas, and of a portion of the gas from which the hydrocarbons had been removed by absorption. Then, indicating the total volume of heavy hydrocarbons by V, the volume of carbonic acid formed by their combustion by Vco_2, and the contraction due to their combustion by Vc, the volumes of ethylene (Ve), propylene (Vp), and benzene vapor (Vb) are given by the following equations:

$$Ve = 5V - 2\,Vc$$

$$Vp = \frac{8Vc - 14V - Vco_2}{3}$$

$$Vb = \frac{2\,V + Vco_2 - 2\,Vc}{3}$$

Evidently, however, the small volumes of the gases which must be dealt with in this method of estimation require the analytical work to be carried out with the utmost precision, entailing the use of exact apparatus and the expenditure of much time. Moreover, the calculation takes it for granted that the three constituents named comprise the whole of the heavy hydrocarbons, and such an assumption is not justifiable.

W. Hempel and L. M. Dennis have attempted to determine the vapor of benzene volumetrically. They employ, as absorbent, 1 c.c. of absolute alcohol saturated with gas, in a mercury gas pipette. The alcohol vapor is subsequently washed out of the gas by 1 c.c. of water, in a second pipette. The author has not obtained satisfactory results with this method.

Bunsen had previously used absolute alcohol to absorb vapor of benzene. He passed the gas under examination over calcium chloride, and then through a wash bottle that contained alcohol. He separated the absorbed benzene from the alcohol by diluting it with water; and he then dried and weighed the benzene.

Bunte, in a similar manner, retains the vapor of benzene in a vessel charged with paraffine oil, and kept cool by means of ice. He deduces the amount of benzene directly from the increase in weight of the absorption vessel. According to Müller, the process gives satisfactory results if several absorption vessels are used in series.

Sainte Claire Dèville separates the vapors of hydrocarbons in the liquid or solid state from coal gas by cooling to —22° C., and weighing the condensed hydrocarbons. The chief defect of this method is the practical difficulty of maintaining a low uniform temperature during the condensation, which extends over one to three hours.

Knublauch has propounded a method of a rather problematical character. He determines the total quantity of hydrocarbons in the usual manner, and observes the illuminating power of the gas. Then, from the known specific illuminating value of each of the two series of hydrocarbons, he calculates the relative proportions of benzene and ethylene in the gas.

Berthelot's method of separating ethylene quantitatively from vapor of benzene by means of bromine water, and absorbing the benzene by fuming nitric acid, is quite unreliable. Treadwell and Stokes have pointed out that the nitric acid absorbs also some carbonic oxide; and that bromine water attacks the vapor of benzene. In fact, many gas chemists estimate the whole of the heavy hydrocarbons by absorption by bromine water.

Harbeck and Lunge have proposed to separate ethylene from the vapor of benzene by passing the gas over platinum-black, thereby adding hydrogen to the ethylene and forming ethane, which is not absorbed by sulphuric acid. Unfortunately, this method is useless with gases—such as coal gas—which contain carbonic oxide, the presence of which renders the system inapplicable. The process has been described in our pages, together with the second plan devised by the same chemists. This second method affords a more reliable separation of ethylene and the vapor of benzene than any of the processes described above. Briefly, it consists in drawing about ½ cubic foot of the gas under examination through a series of ten bulbs blown in a glass tube, which are charged with 100 c.c. of nitro-sulphuric acid, which absorbs the whole

of the heavy hydrocarbons. Absorption vessels charged with caustic soda retain the acid vapors, and also the carbonic acid in the gas, so that the gas passed through the bulbs is measured in the aspirator unaffected by the tension of the acid vapors. It is measured under atmospheric pressure; and the volume is reduced to standard conditions of temperature and pressure. Rubber plugs and tubing used in the train of apparatus must be smeared with vaseline to protect them from the action of the acid fumes. The acid used is diluted by pouring it on to ice, and is then neutralized with caustic alkali cooled by ice. The dinitrobenzene formed from the vapors of benzene in the gas is then filtered off. It is taken up in ether, which is allowed to evaporate; and the residue is then taken up again with a little absolute ether, filtered into a weighed dish, and the ether once more evaporated. After drying at 70° to 80° C., or over sulphuric acid in a vacuum, it is weighed. The weight of dinitrobenzene thus found, multiplied by $\frac{1}{2}\frac{3}{8}$, gives the weight of benzene; and thence the percentage by volume of vapor of benzene in the gas may be calculated. The method not only effects a quantitative conversion of the benzene vapor into dinitrobenzene, but it completely separates the ethylene, so that it seems well adapted for the examination of illuminating gas.

The originators of the method, however, confess that it is troublesome, both in respect of the apparatus required and of the actual operations; and they recommend it for use only as a reliable controlling method in very important work. The exactness of the process, however, seems open to question. The measurement of the volume of the gas passed through the absorbent is complicated by the fact that it is the residual gas alone which is measured; and the total quantity of heavy hydrocarbons and of carbonic acid must be ascertained and added to the volume of residual gas, to give the true volume of the original gas. But the observation of Treadwell and Stokes, already alluded to, that carbonic oxide is partially absorbed by nitric acid, seems to make the calculation of the true volume of the gas very unreliable. The author has found that drying the dinitrobenzene by heat or in a vacuum causes a loss, as that preparation begins to sublime at temperatures below its melting point (90° C.). Finally, the author found that dinitrobenzene of a sufficiently high degree of purity was obtained from coal gas only by very careful purification of the products of nitration.

The author's simplified method determines the vapor of benzene likewise as dinitrobenzene; but he considers that the determination is both simpler and more exact than by Harbeck and Lunge's method. The apparatus used is a stoppered separating funnel, capable of holding about 3 to 4 liters (say, ¼ cubic foot), and the exact capacity of which is known. The funnel is inverted, and its upturned outlet nozzle is connected by rubber tubing with the gas supply; the inflowing gas rapidly displacing the air in the funnel. When filled with gas, the funnel is closed; both the stopper and the stopcock having been previously lubricated with a little sulphuric acid. The gas within is reduced to atmospheric pressure by momentarily opening the stopcock; and the height of the barometer and the temperature of the laboratory are noted. There is then poured into the outlet nozzle of the inverted funnel 10 c.c. of a mixture of equal volumes of concentrated sulphuric acid and fuming nitric acid of 1.52 specific gravity. By careful opening of the stopcock, this 10 c.c. of acid can be run into the funnel without the escape of any of the contained gas. The funnel is then inclined, and the acid is made to wet its interior throughout. The wetting of the walls of the funnel is repeated occasionally during the ensuing hour; the funnel in the intervals reposing horizontally in a suitable frame.

In this period the absorption of the heavy hydrocarbons will be completed. Then 100 c.c. of water is poured quickly through the ordinary mouth of the funnel, the stopper is re-inserted, and the funnel is shaken so that the water takes up the acid from the walls. The slightly warm liquid contains the products of nitration of the hydrocarbons, partly in solution, and partly, if much benzene was present, as small crystals which render the liquid turbid. The pale yellow liquid is washed out into a smaller separating funnel, of about ½-liter capacity. The acid is then neutralized by the addition of 40 grammes of soda crystals. A small excess of the latter is not harmful; but a large excess of alkali makes the subsequent separation of water and ether difficult. The color of the liquid changes to reddish orange as it becomes alkaline. Next 50 c.c. of ether is added; and the funnel is agitated while held in the following manner. The right hand firmly holds in the stopper of the funnel, while the left hand holds the outlet nozzle, which is turned upwards, so that the outlet is closed by the thumb of that hand. The stopcock remains open; and by moving the thumb of the left hand, the operator is able to release the excess of pressure, due to the tension of ether and the escape of carbonic acid, without loss of liquid. After a time, the stopcock may be closed, and the agitation continued. The clear aqueous liquid is then run off from the ethereal extract; and the latter is purified by washing twice or thrice with about 10 c.c. of water. The uncrystallizable products which would render the dinitrobenzene dark in color are removed by the washing. The ethereal extract is washed out by means of a little ether into a 200 c.c. flask. The aqueous liquid and washings are extracted with ether a second time in a precisely similar manner. In particularly important cases, a third extraction should be made. The ethereal extracts are brought together and distilled on the water bath. The oily residue is taken up with a little absolute ether (0.720 sp. gr.); and the light yellow solution is filtered through a funnel containing a plug of cotton wool on which is a layer of about 1 gramme of freshly calcined soda, into a weighed dish. The contents of the funnel are washed with absolute ether until the washings are colorless. The washings are run into the dish with the filtrate. The soda retains traces of water and impurities. After the ether has evaporated, the dish is brought without delay into an exsiccator charged with sulphuric acid, and left in it over night. The dish, which contains the crystals of dinitrobenzene, is then weighed.

The percentage by volume of vapor of benzene in the gas under examination is calculated from the weight of dinitrobenzene obtained, by the following expression:—

Percentage of vapor of benzene =

$$g \times \frac{13}{28} \times \frac{1{,}000}{3.582} \times \frac{(273 + t)\,760}{273 \times b.} \times \frac{100}{\mathrm{J}}$$

in which g = the number of grammes of dinitrobenzene obtained;
J = the number of cubic centimeters of gas taken (*i. e.*, the capacity in cubic centimeters of the separating funnel);
t = the temperature in degrees centigrade of the laboratory at the time the funnel was filled with gas; and
b = the barometric pressure in millimeters of mercury at the same time.

This expression may be simplified by combining its constant factors, and then becomes—

$$\frac{36{,}080}{\mathrm{J}} \times g\frac{273 + t}{b};$$

and, as J is constant for a given separating funnel, the value $\frac{36{,}080}{\mathrm{J}}$ becomes reduced to a simple figure.

Harbeck and Lunge had demonstrated that vapor of benzene could be quantitatively separated from ethylene by their method, which has already been described. Nevertheless, it seemed to the author desirable to prove that his adaptation of the same principle likewise afforded a quantitative separation of those hydrocarbons. With this object, he weighed in a sealed bulb about 0.25 gramme of pure benzene, boiling at 80.4° C., and introduced the bulb into the large separating funnel. He then caused a partial vacuum in the vessel by suction, in order to give space for the vapor of the benzene. The bulb was then broken by shaking the funnel, and the benzene rapidly vaporized. Next 10 c.c. of the nitrating acid was introduced into the funnel, which was manipulated as in an analysis of gas by this method, though the time occupied by the manipulation was shortened usually to a quarter or half an hour. The nitration products were also dealt with as in the analysis already described. The following figures show the degree of exactness of the method of estimation:

	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)
Benzene taken, grammes	0.2804	0.2522	0.2258	0.2610	0.2340
" found, "	0.2776	0.2492	0.2258	0.2607	0.2344

The nitration, therefore, takes place quantitatively, and is completed in a quarter of an hour. It was further established by trial that cooling the nitrated mixture by ice on its dilution was superfluous, and that drying the dinitrobenzene in the warm or in a vacuum leads to loss. Indeed, the dinitrobenzene may be completely sublimed at 70° to 80° C. The author's earlier estimations, in which he dried the product at that temperature, failed on this account. Harbeck and Lunge were able to secure satisfactory results because the quantities of dinitrobenzene weighed by them were very much greater. The following are the results of some determinations of the vapor of benzene in coal gas:

—	Volume of Gas Taken, Cc.	Barometric Pressure. Mm.	Temperature. °C.	Percentage of Vapor of Benzene Found.
a	10,570	759	22	1.15
b	1,163	762	26.5	1.82
c	3,411	764	23	1.51
d	3,411	762	23	1.55
e	3,411	760	17	1.72
f	3,411	766	19	1.52
g	1,398	759	26	2.13
g'	3,411	759	26	1.97

It should be mentioned that *a* was carried out by Harbeck and Lunge's original method; *b*, by the use of Rüdorff's apparatus for the estimation of carbonic acid, but in other respects according to the author's method. The other tests were made by the author's method; and *g* and *g*^{1} refer to crude gas, at the inlet and outlet respectively of a "Standard" washer.

A calculation of the amount of vapor of benzene may be made from the analysis and the specific gravity of a gaseous mixture, just as, conversely, the specific gravity of such a mixture can be calculated from the analysis and the specific gravity of the constituents. If the specific gravity of the gaseous mixture=S, the mean specific gravity of the whole of the heavy hydrocarbons ($C_n H_m$) present in it=*s*, and the symbols *a*, *b*, *c*, *d*, *e*, *f*=the percentages by volume of carbonic oxide, marsh gas, hydrogen, nitrogen, carbonic acid, and heavy hydrocarbons respectively, then

$$s = 100\ S - (0.9671\ a + 0.5530\ b + 0.0692\ c + 0.9701\ d + 1.5197\ e)\frac{1}{f}$$

Thus in a gaseous mixture of which the specific gravity (S) was found experimentally to be 0 3882, and of which the analysis gave the figures shown below, the specific gravity (*s*) of the heavy hydrocarbons would be found in the manner shown.

Constituents.	Percentage by Volume. (x)	Specific Gravity. (y)	($x \times y$) Weights.
Carbonic oxide.....	8.4	0.9671	8.123
Marsh gas	30.7	0.5530	16.970
Hydrogen.....	54.2	0.0692	3.751
Nitrogen.....	1.5	0.9701	1.455
Carbonic acid.....	1.4	1.5197	2.127
Heavy hydrocarbons...	3.8	*s*	....
			32.426

$$\text{Therefore } s = \frac{38\ 82 - 32.43}{3.8} = 1.682$$

The specific gravity *s* refers to the mixture of heavy hydrocarbons consisting chiefly of ethylene and vapor of benzene. On the presumption that the higher homologues have little importance, because the quantities of them are very small, the value *s* will always lie between the specific gravity of ethylene (0.9674), and that of the vapor of benzene (2.7041). It will approach more nearly to the one or the other of these values, according as ethylene or vapor of benzene predominates. Hence it follows that the quantities of ethylene and benzene in the mixed hydrocarbons stand in inverse ratio to the differences between their specific gravities and that *s* of the mixed hydrocarbons. Thus—

$$\text{Ethylene} : \text{Benzene} :: (2.7041 - s) : (s - 0.9674)$$

If the total volume (v) of heavy hydrocarbons has been ascertained by analysis, the percentage of vapor of benzene in the gas can be calculated thus—

In $(2.7041 - s) + (s - 0.9674)$ volumes of heavy hydrocarbons there are present $(s - 0.9674)$ volumes of benzene. Therefore in v volumes of heavy hydrocarbons, there will be

$$\frac{(s - 0.9674)\ v}{(2.7041 - s) + (s - 0.9674} = \frac{(s - 0\ 9674)\ v}{1.7367}$$

volumes of benzene vapor.

The quantity of ethylene is determined by deducting the amount of vapor of benzene found from the total quantity of heavy hydrocarbons. In the example of an analysis already given, the amount of benzene present would appear by calculation to be $\frac{(1.682 - 0.9674)\ 3.8}{1.7367} = 1.56$ per cent. of vapor of benzene; and therefore the amount of ethylene would be = 2.24 per cent.

Critical consideration of this method of calculation leads in the first place to the conclusion that the wide difference in the specific gravities of ethylene and vapor of benzene is very favorable to the return of reliable results from its application. On the other hand, the inherent weaknesses of the process must not be overlooked. An exact complete analysis of the gas is needed; and the determination of the total heavy hydrocarbons in particular must be free from error. An error of 0 2 per cent. in this determination would, in the foregoing example, have made a difference of 0.1 in the percentage of benzene found.

The effect of the higher homologues of ethylene and benzene cannot be of much moment, as it diminishes with the quantity present; and this quantity in coal gas is relatively very small. Practically their presence in the gas is compensated for in the results, as they possess higher illuminating value and higher calorific value as the molecular weight increases; so that an increase in the specific gravity (*s*) due to higher homologues, causes an apparent increase in the quantity of benzene vapor present, and the vapor of benzene has a higher illuminating value than ethylene. Hence, so far as the valuation of the gas in respect of illuminating power is concerned, the results obtained by the method are reliable, and are of more practical utility than would be an exact determination of the vapor of benzene alone. The weakest point in the process is the determination of the specific gravity of the gas experimentally, as the apparatus in vogue for this determination does not give sufficiently accurate results.

The gas balance does not, as a rule, give results which are accurate even to the second decimal place. The Bunsen-Schilling effusion apparatus gave concordant results in a series of tests; but the numbers obtained are at best only approximate, and unreliable *beyond* the second decimal place. A difference of 0.005 is of frequent occurrence; and an error of this magnitude in the determination of the specific gravity would in the example cited above, cause an error of 0.3 in the percentage of vapor of benzene found. But by taking the mean of several determinations of the specific gravity of the gas, the author has secured by the method of calculation very satisfactory results, which agree closely with those obtained by the nitration method. Thus, it will be seen that the amounts of benzene and ethylene in five samples of gas, calculated from the appended analyses, agree closely with the results obtained by the nitration method, which have already been quoted under tests (*a*), (*b*), (*d*), (*e*) and (*f*) in the table given above.

Constituents of Gas.	Volumes per Cent. (*a*)	(*b*)	(*d*)	(*e*)	(*f*)
Carbonic oxide.....	8 4	8 7	8.4	8.7	8.0
Marsh gas.....	31.4	28.8	30.7	30.2	31.5
Hydrogen	53.6	56.0	54.2	54.3	54.1
Nitrogen.....	1.2	1.5	1.5	2.0	1.6
Carbonic acid.....	1.4	1.5	1.4	1.4	1.4
Hydrocarbons ($C_n H_m$)	4.0	3.5	3.8	3.4	3.4
Specific gravity of—					
Gas (S).....	0.3861	0.3816	0.3882	0.3906	0.3860
Hydrocarbons (*s*).....	1.6250	1.7710	1.6820	1.8000	1.7710
Calculated percentage of—					
Benzene vapor.....	1.28	1.62	1.56	1.63	1 57
Ethylene	2.72	1.88	2.24	1.77	1.83
Percentage of benzene vapor by the nitration estimation.....	1.15	1.82	1.55	1.72	1.52
Percentage of ethylene by the nitration estimation	2.85	1.68	2.25	1.68	1.88

The foregoing results indicate that the determination of benzene and ethylene by calculation from the specific gravity and analysis of the gas suffices for general use, and serves to complete the analysis. But occasionally controlling determinations should be made by the nitration method, and the extent of the agreement of the results observed, with gaseous mixtures of different composition. The precision of the method of calculation will be greatly enhanced by elaboration of more nearly perfect methods of determining the specific gravity of gas.

The Gas Engine in the Foundry.

By Mr. George A. True.

It is somewhat surprising that, in considering the various powers which can be applied to foundry use, the gas engine has not received more attention. It is probably due to the fact that mechanical people, as a rule, are less familiar with the advantages of this power than are the manufacturers who are not in the machine trade, or in any other mechanical line of business.

For a number of years this type of engine has been steadily growing in favor with manufacturers of clothing, with printers, farmers, millers, elevator men, and in various kindred lines, but it does not seem to have made much headway, until recently, in foundries or machine shops. In fact, the mechanical world does not seem as well acquainted with the practical use of this power as does the farming community. One reason for this is probably that in foundries and machine shops the use of steam in some form is more or less necessary, and the managers have figured that if an engineer is necessary to keep steam on the boiler, they might as well use a steam engine. In some locations this may be a good reason; in others it is not.

The past ten years has witnessed the introduction of thousands of electric motors in iron manufacturing plants in small units, driving isolated machines. There can be no question of the value of electric power in a great many cases for such duties, but there are many loca-

tions where a gas engine could be applied to similar service and where the actual cost of operating with a gas engine would not exceed 50 per cent. of the cost of operating by any other means.

Within the past month the trade journals have published notices of the installation of several gas engines by one large Eastern malleable iron plant. The foundry is especially a place to which the gas engine can be readily applied. As a rule, the groups of machines are widely separated as to location. The blower and tumbling barrels are very often located at extreme opposite ends of the shop. Very often it is necessary to operate the elevator at a time when no other power is required. Again, it is convenient to operate tumbling barrels when no power is required for elevator or blower. In such situations the gas engine can be readily adopted. It is not dependent upon a central power station. It is an entirely independent prime motor, can be instantly started and stopped, and the consumption of fuel goes on only while the engine is operating. This is not strictly true of any other system. All other methods of power distribution are dependent upon a central power station. The gas engine is a unique factor as a prime motor.

But the greatest commercial value of the gas engine lies in the small cost of the fuel it consumes. In using the term "gas engine," we refer to the engine using either natural or artificial gas, or to the gasoline engine, which, as a rule, can be used with gas by making a slight change in the valve mechanism. Many engines now on the market can be changed from gas to gasoline instantly while running. It is common to speak of the cost of fuel consumption in these engines as about 1 per cent. per horse power per hour. It will average less than this. In some of our large cities, where cheap natural gas is used, it will not exceed four tenths of a cent per horse power per hour. A 2-horse power gas motor, the fuel cost of which is 8 cents a day, ought to be an interesting factor in power production.

In addition to the economy resulting from the low cost of fuel, the fact that a gas engine does not require a licensed engineer, and that any machinist of fair ability can look after it and keep it in good running order in connection with his other duties, makes it a very desirable motor for shops where machinists or mechanical men are employed. There has been a great deal of talk about gas engines being unsatisfactory on account of frequent repairs and the inability of the purchaser to keep them in good running order. In about 90 per cent. of these cases the trouble can be traced, not to the engine, but to the fact that the proper kind of a man is not looking after it. The very fact that farmers, bakers, butchers, etc., have used so many of these engines, gives a hint of the cause of complaint. These people, as a rule, are totally unacquainted with mechanical details of any kind, and when a battery runs out, or any little detail about the engine gets out of order, they are unable to understand it, and become discouraged without making any effort to remedy the defect. This is not true of a machinist or a mechanical man, because, with a very small expenditure of time, he can find the difficulty and remedy it. There is no reason why a few extra wearing parts should not be constantly kept in stock. They cost less than one month's fuel saving usually.

In one large plant now being installed in a Pittsburg foundry, several large gas engines are being used to drive generators developing electricity, which is carried to electric motors running groups of tools throughout the plant. This is another admirable application of the gas engine, as it enables the manufacturer to produce his electric power at about one-half the cost of its production by steam, and this is a matter which ought to make the gas engine a welcome competitor, even to the electric motor manufacturers. In this case instead of being a rival of electricity, it is an aid, by becoming a prime generator of electric current.

The subject is a broad one and cannot be covered in a short talk, but it is one worthy of study by those who are wrestling with the subject of a cheap and safe power.

There are undoubtedly a great many situations where steam and electricity are expressly indicated, but there are also many power conditions which call especially for the gas engine, and it will be surprising if there is not a larger demand for it among foundries, steel plants and machine shops in the future.

Latent Heat of Evaporation of Liquid Air.

[By Mr. Walter H. Dickerson, in Stevens Institute *Indicator*.]

During May, 1898, the writer, in connection with Prof. D. S. Jacobus, made some determinations of the latent heat of evaporation of liquid air at the Stevens Institute of Technology.

As a result of the investigation the latent heat of evaporation a atmospheric pressure was found to be 123.0 British thermal units per pound.

The method of determination was as follows:

A large mercury mirror Dewar vacuum bulb was employed to contain the liquid air. The vacuum bulb consisted simply of two glass bulbs, one within the other, and joined in a short neck.

These bulbs have, between the walls, an annular space of about one-half inch, which is exhausted to a very high vacuum. If a drop of metallic mercury is orginally introduced into this vacuum space, it will be changed into vapor when the vacuum is formed. On filling the inner bulb with liquid air, the mercury vapor in the vacuum space will be condensed on the surface of the inner bulb and a mercury mirror formed. The vacuum space prevents ingress of heat to the liquid air by direct convection and the mercury mirror intercepts the radiant heat so that the rate of evaporation in this form of containing vessel is very low.

The vacuum bulb was filled with liquid air and weighed, and the rate of constant evaporation due to the heat of the atmosphere determined. A small bar of metal of known weight and temperature was then introduced into the liquid air and after it had acquired the temperature of the liquid, it was withdrawn and the bulb weighed again, the length of time the metal bar was in the liquid air being noted. Then, knowing the initial and final temperatures, specific heat, and weight of metal bar, and also the weight of the liquid air evaporated, the latent heat of evaporation of the liquid air could be calculated.

No means were at hand to determine the temperature of the liquid air, and it was therefore taken as the boiling point at atmospheric pressure and temperature, given by Prof. Dewar and others as —312° F., or —181.4° C. Although the liquid air used was slightly richer in oxygen than the ordinary atmospheric air, the error due to the difference of temperature from this cause was considered well within the error of other observations and was therefore disregarded.

There were three determinations made, with a different metal in each instance. The three metals used were iron, copper and aluminum, each in the form of a small cylindrical bar. The specific heats of these particular bars had previously been determined for a range of temperature from the atmosphere to the boiling point of liquid air with the following results:

Metal.	Weight of Bar in grammes.	Specific Heats.
Iron.....	51.925	.0914 for range of temperature of from + 13.°C. — 181.4°C.; .1162 for above + 13.°C.
Copper.....	63.49	.0868 from + 11°C. to — 181.4°C. .094 for above + 11.°C.
Aluminum.	19.865	.1833 from + 14.5°C. to — 181.4°C. .2173 for above + 14.5°C.

During the tests the following observations were noted:

First Experiment with Iron Bar.—Temperature of atmosphere, 23.9°C.

Temperature of iron bar, 23.6°C.

Total weight of vacuum bulb and liquid air before immersing iron bar, 338 grammes.

Total weight after iron bar had acquired temperature of liquid air and been withdrawn, 319 grammes.

Time between weighings, 10.5 seconds.

Rate of constant evaporation per minute due to heat of atmosphere, .4286 grammes.

Total constant evaporation, 4.500 grammes.

Net evaporation due to iron bar, 14.5 grammes.

Heat units in iron per gramme—

+ 13° C. to — 181.4° C.....	= 17.768
+ 23.6° C. to + 13° C.....	= 1.232
Total heat units per gramme.....	19.000

Total heat units in iron bar in gramme-calories + 23.6° to — 181.4° = 986.57.

Latent heat, by iron bar, 68.03 calories.

Second Experiment with Copper Bar.—Temperature of copper bar, before immersing, 23.2° C.

Weight of bar, 63.49 grammes.

Weight of vacuum bulb and liquid air before immersing copper bar, 312 grammes.

Weight of vacuum bulb after bar had acquired temperature of liquid air and been withdrawn, 291 grammes.

Time between weighings, 10.92 minutes.

Rate of constant evaporation per minute due to heat of atmosphere, .4342 grammes.

Total constant evaporation, 4.741 grammes.

Total evaporation, 21 grammes.

Net evaporation due to copper bar (21 — 4.741) 16.26 grammes.

Heat units in 1 gramme copper—

+ 11° C to — 181.4° C.....	= 16.70
+ 23.2° C. to + 11° C.....	= 1.15
Total + 23.2° C. to — 181.4° C..... ..	17.85

Total heat of copper bar in gramme-calories, 1126.948.

Latent heat of evaporation of liquid air by means of copper bar, 69.31 calories.

Third Experiment with Aluminum Bar.—Temperature of aluminum bar before immersing, 23° C.

Weight of bar, 19.865 grammes.

Weight of vacuum bulb and liquid air before immersing aluminum bar, 284 grammes.

Weight of vacuum bulb after bar had acquired temperature of liquid air and been withdrawn, 269 grammes.

Time between weighings, 9.4165 minutes.

Rate per minute of constant evaporation due to heat of atmosphere, .4166 grammes.

Total constant evaporation, 3.9229 grammes.

Total evaporation, 15 grammes.

Net evaporation due to heat of aluminum bar, 11.077 grammes.

Heat units per gramme of aluminum—

+ 14.5° C. to — 181.4° C.....	= 35 908
+ 23° C. to + 14.5° C.....	= 1.847
Total	37.755

Total heat in aluminum bar used, 750.1 calories.

Latent heat by aluminum bar, 67.72 calories.

Average latent heat by iron, copper and aluminum bars, 68.35 calories.

Latent heat expressed in B.T.U. per pound, 123.03.

The writer wishes to express his thanks to Mr. Chas. E. Tripler for so kindly furnishing the liquid air with which to make the investigation; also to Prof. Trowbridge, Columbia University, for loaning the metal bars and furnishing the data of their respective specific heats.

The Explosive Features of Acetylene.

The *Scientific American* says that the rapidly extending use of acetylene and the fact that its widening range of application is putting it increasingly into unskilled hands, render the question of its explosive properties a vital one to the community at large. In the earlier stages of its manufacture and use the new illuminant suffered somewhat in reputation from the recurrence of explosions more or less destructive and fatal, and there was for awhile a danger of its field of usefulness being narrowed by a popular fear as to its safety, out of proportion to the facts. Thanks, however, to exhaustive experimental work in the laboratory, the explosive possibilities of acetylene have been determined with accuracy, and it is now possible to manufacture, transport and use the new illuminant with something of the same immunity from accident that characterizes the familiar coal gas.

Pure acetylene gas, when under atmospheric pressure, is not explosive. This was proved by Berthelot and Vieille before acetylene was looked upon as having commercial value, and as soon as its production on a commercial scale became certain, they took up the question again and confirmed their earlier experiments with the following statement: "Under atmospheric pressure and at a constant pressure, acetylene does not propagate to an appreciable distance decomposition provoked at any point. Neither the electric spark nor the presence of an incandescent wire, not even the detonation of a fulminate primer, exercises any action beyond the vicinity of the region subjected directly to the heating or shock."

As the pressure of the gas arises above that of the atmosphere, it becomes liable to explode, but it is not possible to state the exact critical pressure above which a definite exciting cause will, and below which it will not, render acetylene explosive. Berthelot and Vieille state that when the exciting cause is an incandescent wire in the gas, the maximum allowable pressure is 10.5 pounds gauge, and when the cause is the detonation of a fulminate cap, 3.5 pounds is the limit. These two causes of explosion were taken as representing the extreme conditions that could obtain in faulty manufacture and manipulation of the gas, the first representing intense local heating in calcium carbide attacked by a small amount of water, or caused by intense friction due to the rush of gas through a valve. The second case, which would be represented in the formation and detonation of acetylides, is not liable to occur in the commercial production of acetylene, but could only happen under special laboratory conditions.

Liquid acetylene, therefore, on account of its condensed state, is naturally susceptible to explosion, detonation being caused by high temperatures, sparks, or heavy shocks to the liquid itself. Berthelot detonated a steel bomb filled with liquefied acetylene by means of an incandescent wire, the pressure gauge showing a pressure of 5.383 atmospheres; but liquefied acetylene contained in cylinders was shown by the same experimentalist to be proof against detonation by shock, a cylinder charged with 300 grammes of the liquid falling repeatedly upon a steel block from a height of 19.5 feet without explosion. A direct blow upon the liquid itself may heat a small portion to a dangerous temperature, whereas the same blow to the cylinder would be only partially transmitted, and what portion did reach the liquid would be absorbed by the whole liquid mass. A real peril exists at the cylinder and reducing valves, due to the sudden arrest of the column of gas at the reducing valve raising its temperature adiabatically to the explosion point.

Acetylene is more dangerous than illuminating gas in forming explosive mixtures with air, for not only is the ignition temperature lower, but the explosive energy is greater, and the range of the explosive proportions of the gas and air is wider. Thus a mixture of one volume of illuminating gas with one or with two volumes of air will not burn; whereas a mixture of similar proportions of acetylene gas and air burns with a sooty flame. In the case of each gas a mixture of one volume of the gas to three of the air is explosive. The strongest explosive in the case of acetylene is one to nine, and in the case of illuminating gas one to six. But whereas the latter ceases to explode at one to twelve, acetylene mixtures do not become non explosive until the proportion is one to twenty. The temperature of ignition varies but little with the proportions of the mixture, and is placed at 900° F. for acetylene as against 1,100° F. for most combustible gases.

The Yield of Centrifugal Fans.

A contributor to *Mines and Minerals* says: The question is often asked what volume of air will a certain fan produce if its speed is increased, say, from 50 revolutions per minute to 100 revolutions per minute. The answer commonly given to this question is that the volume of the yield will be in direct proportion to the speed of the fan. Is this the case?

We will suppose the mine is ventilated by a certain quantity of air produced by a fan running at a speed of 50 revolutions per minute. We time the speed accurately by listening to the pulsations of the fan as we stand at the bottom of the downcast shaft. Having given directions to the engineer to maintain a constant gauge pressure at the engine, as nearly as possible, we proceed from the foot of the downcast, a short distance, to a door dividing the main intake of the mine from the main return. The current of air traveling around the working face and through the airways of the mine, meets with what we call mine resistance. This mine resistance is measured by the pressure against which the fan is working. This is the total pressure ($p\ a$) in the fan drift. So far, we understand the conditions clearly; but there are certain variations in these conditions which are not so easily understood, and yet which are absolute facts in mining practice. For example, if we now set open the main door between the intake and return airways, the air instead of passing around the mine will escape through this door and pass immediately up the upcast shaft. There is no circulation, practically, in the mine workings; the air current simply passing down one shaft and up the other. There is, as a result, a fall of pressure in the fan drift, and we might expect that under this decreased pressure the speed of the fan would increase, the same power being applied to the fan shaft as before. This, however, is not the case. The fan, instead of increasing its speed, or as we say, running loose, will slow down under the decreased pressure. If we measure the volume of air passing, we find that it is very much increased; and applying the simple formula, $u = Qp$, we see that the power remaining the same, as the pressure decreases, the quantity increases. If we count the revolutions of the fan, which we can still do in our position at the door, by listening to its pulsations, we find that they are somewhat less than they were before. The same power is used in turning the fan, and should produce the same speed in the fan; but the quantity of air is so in-

creased, owing to the reduction of the resisting pressure, that the work lost in the motor is very much increased. It is this loss of work in the motor, changing the efficiency of the motor, that has caused the decrease in the speed.

Let us look at another case. If, with the main door closed and air current circulating through the mine, we now increase the speed of the fan, we shall increase the quantity of air passing and the pressure; but to do this we must increase the power. Hence we observe that we may increase the quantity in two ways: (1) by increasing the power applied to the air current; (2) by decreasing the resistance against which the current moves. Either of these cases will give an increase in the volume of the current. The one requires an increase of power, and an increase of speed in the fan; while the other results from the same power and a decrease of speed and a loss in the motor's efficiency.

The rule in common practice, that the quantity of air varies as the speed of the fan, is only approximately true in the first case, when this increase of quantity is obtained by increasing the power applied to the fan shaft. But, when an increase of quantity is obtained by the reduction of the resisting pressure, the speed of the fan reduces as the quantity is increased. In this latter case, the increase of quantity is not due to the speed of the fan, but is simply the result of a reduction of the resisting pressure. We see clearly the yield of the fan may be either the result of the power applied to the fan shaft, in which case the speed of the fan is about proportional to the yield; or may result from a decrease of resisting pressure, when the speed of the fan is independent of the yield. In both of these cases the efficiency of the motor changes and the relationship between the speed and the quantity in the first case, or between the quantity and the resisting pressure in the second case, will be altered, owing to the changed efficiency. In practice, where any change of power occurs, we will find that the quantity varies in a slightly less ratio than the fifth root of the fourth power of the speed. When the power remains constant, the speeed will also remain constant, except as it is affected by the efficiency, decreasing with a decrease of efficiency and increasing with an increase of efficiency. The efficiency is always greater when working against a greater resisting pressure, and is decreased by a fall in this pressure.

We must always bear in mind and take into account the conditions producing any change before we can tell the effect of that change. For example, in the above case it makes a great deal of difference whether the increase of air is produced by an increase of power or a decrease of the resisting pressure In the one case, the rule in common use that we have referred to will give approximate results; in the other case it fails absolutely.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

A CORRESPONDENT in Boston, Mass, writing under date of the 4th inst, says:

To the Editors AMERICAN GAS LIGHT JOURNAL: I have read with much interest the article in your issue for November 6th (pp. 736–737), entitled "Pointers on Practical Gasfitting," and beg to make a few sugtions therewith. Natural gas always has an odor, which, however, varies considerably—it would seem that many people have no sense of smell, for the statement is often made that water gas has no odor, which is equally untrue. Natural gas always contains moisture, but this is usually chiefly condensed in the mains, and seldom causes trouble in the houses. Your author is quite right in approving the usual practice of putting natural gas pipe on the outside of houses. The pressure of natural gas may rise, through accident to the regulator or other cause, much higher than artificial gas ever can; hence the wisdom of greater precaution. The statement that excessive pressure may be counteracted in high buildings by running a smaller pipe than usual is an error. This merely aggravates the difficulty by giving a varying pressure instead of a uniformly high pressure at the top of the building. If, for instance, with your small pipe the consumption is very low at a given time, the pressure at the top of the building will be just as high as if you had a larger pipe, and, as the consumption increases, consumers near the top of the building will have to open their gas cocks wider and wider, and when the consumption diminishes again they will have to shut the gas off more and more; and if a gas jet were left lighted, without attention, the pressure might rise high enough to blow it out or to set fire to an adjacent door or wall or ceiling. If, however, you have a uniformly high pressure, the gas will never be turned on enough to cause trouble. Natural gas, for instance, is commonly used in houses at a pressure of from 6 to 8 ounces, without inconvenience or danger.—Very truly yours, GODFREY L. CABOT.

A CORRESPONDENT incloses the following, which goes to show that Manager Mish and Superintendent Smith are fairly booming things in the gas line at Lebanon, Pa.: "In the last week of November the Lebanon Gas Company placed a contract with Messrs. J. H. Gautier & Co., of Jersey City, N. J., for extensive additions to its works. Following the increase of capacity of the plant last summer, the demand for the Company's product has so increased that a material enlargement of its generating capacity could not be delayed. The contract just awarded calls for the placing of an additional bench of 6's, and the agreement with the contractors is that the work shall be finished in two months. The plans include arrangements for the further placing of two benches of 6's."

IT is said that Mr. J. A. Bower, who is a prominent figure in the contracting firm of Dawson & Co., of Mason City, Ia., will construct the gas plant that is to be operated on municipal account at Dysart, Ia.

"L. S.," writing under date of Dec. 2, says: "Yesterday the proprietors of the Mohawk Gas Company, of Schenectady, N. Y., put into effect the new selling schedule. Under it the all round use of gas will cost $1.50 per 1,000 cubic feet, less 20 cents off for prompt payment—within 10 days. Heretofore the rates were: $2 per 1,000 gross for illuminating use, less 20 per cent. for prompt payment; $1.60 for fuel use, less 20 per cent. for prompt payment." That is pretty cheap gas for Schenectady, and it seems the figures should look something like "wall handwriting" for the folks in control of the gas supply of Albany and Troy.

MANY residents of Quincy, Ills., responded in person to this invitation, extended by Mr. H. E. Chubbuck, General Manager of the Quincy Gas and Electric Company, in the last week of last month: *To Our Patrons*—The Quincy Gas and Electric Company extend to you a cordial invitation to visit the Empire electric light plant, which is now completed, during the evenings from November 29 to December 6 inclusive. There will be in attendance electrical experts who will explain the various electrical devices to those who honor us with their presence.

THE certificate of incorporation of the Hawthorne and North Paterson Gas Company was filed some days ago. It proposes to operate in the named towns of New Jersey, is capitalized in $100,000, and its Directors are: I. Myers, E. B. Ackerman, Jos. Risdon, J. J. Grady, Edward A. Reser, A. R. Kingsbury, W. C. Williamson, F. J. Ring, D. W. Warren, D. R. Clark, W. G. Merritt, William Johnston, Ernest Burt and *B. Van Steenbergh*. The italics are ours.

THE County Commissioners, of Houlton, Me., have about determined to change the lighting of the county buildings from the electric to the acetylene gas system. The Commissioners figure that the saving through the substitution will be equal to 50 per cent. of the money heretofore expended per annum on the account named.

HERE is a story from the columns of the San Francisco *Call.*, of the 28th ult., which is given for what it is worth: "In paying the taxes of some $80,000 yesterday, the San Francisco Gas and Electric Company, through an error of Wells, Fargo & Company's bank, paid exactly $40,000 too much into the city treasury, or a total of $120,000. The error was discovered by Treasurer Truman's deputies, and the surplus money was returned to the bank's representative. When the bank opened yesterday morning one of the officials of the Gas and Electric Company presented a check for $40,000, and four sacks of money, supposed to contain $10,000 each, were delivered to him and immediately conveyed to the Tax Collector's office. The taxes were paid with demands held by the Company against the city for a little over $40,000, and the four sacks of coin supposed to contain $40,000 and a receipt given. The money was taken to the Treasurer's office immediately, where the mistake was discovered and restitution of the $40,000 made."

LAST month, and almost to its close, one who read the local papers of Colorado Springs, Col., would imagine or believe that the plant of the Colorado Springs Light and Power Company had been put out of business, because of an explosion in the generating division thereof. There was some sort of trouble in the generating end, but the water gas maker can tell the rest. The damage to property was less than $200; unfortunately, though, the damage to person was more, in that the Company's Superintendent, Mr. W. C Paullins, loses temporarily through the accident from injuries the services of an efficient employee.

ABOUT as well compiled a catalogue that we have received, describing the advantages of a "College of Engineering," is the one to hand

that details what the Ohio State University gives to its students. Its faculty is numerous—almost everything in Ohio is multipliable—and its head is Rev. William Onley Thompson, D.D., flanked by Nathaniel Wright Lord, E.M., and Dr. Edward Orton, to whom the gas interest owes much.

THE signs of dickering go to show that the natural gas interests of Washington, Pa., have pooled their interests.

CURRENT information is to the effect that the Sing Sing (N. Y.) Lighting Company has been incorporated to supply "gas and electricity in Sing Sing and other towns and villages of Westchester county." Its capital stock is $50,000, and the dummy Directors are: John T. Kirk and B. F. Williams, of Brooklyn, N. Y.; and L. B. Lampman, of Cocksackie, N. Y.

"F. P.," sending a word or two along by letter, explanatory of certain matters relating to the gas supply, "in the future," of Toledo, O., says: "I forward the JOURNAL two newspaper articles, from which you can see we have other great, big, learned men in Toledo besides our 'Sammy Jones,' who wasn't elected Governor last fall. The mainstay in the newspaper accounts of the enterprise for the 'new' lighting of Toledo is Mr. Homer T. Yaryan, Manager of the Toledo Heating and Lighting Company, a concern that proposes to sell hot water heat for residences (he must be a bachelor), and to give away or sell electric currents for the lighting of the residences so heated. If Mr. Yaryan shows a like bright knowledge in his own business that he is about to show in this trading in Toledo, we may all excuse him through his inability to understand anything other than the orders of his boss. The people of Toledo have had about enough of the virtues and economies of municipal ownership, and so I may be forgiven for remarking that the Governor that isn't may be excused for doing his best just now to saddle anything he can upon the city in his final round-up with politics."

THE old plant of the Charlotte (N. C.) Company is to be removed to Raleigh, N. C., with Mr. S. E. Linton superintending the transfer.

THE excursionists, voyagers and others who winter in Florida this season will, if they journey to Palm Beach west, have the illumination afforded by the combustion of acetylene gas.

THE residents of Bristol, Tenn., think the Bristol Gas and Electric Company is charging too much for the service it gives in respect of both of its divisions. That is not an uncommon thought in other sections of the South, whose proverbial sleepiness cannot brook the idea that home affairs might be better managed by outsiders than by insiders. Bristol, even though it makes coal gas, is slow.

MANAGER PHILIP CROSS, of the Syracuse (N. Y.) Gas Company—he is more of a gas maker and gas seller than he is of a bond printer or bond broker—does not think that gas can be sold just now at a profit to the Company at the rate which the residents of the Salt City would like to have—$1 per 1,000 cubic feet.

AT a regular meeting of the Directors of the Worcester (Mass.) Gas Light Company, held the afternoon of the 4th inst., the following action was taken: "*Voted*, That, on and after February 1st, 1900, the price of gas be reduced to $1.20 per 1,000 cubic feet, with a discount of 20 cents per 1,000 on all bills paid on or before the 15th day of the month in which they are presented, thus making the net price of gas to the consumer $1 per 1,000 cubic feet." This shows that Mr. Lamson and his associates are quite up to the trust that their duty to their shareholders and to their consumers imposes upon them.

THE Clinton (Mo.) gas, electric light and water properties have been consolidated, under the ownership of Mr. John L. Woolfolk and his associates.

MESSRS. DEILEY & FOWLER have been awarded the contract for the construction of a storage holder for the York (Pa.) Gas Company. It will be equal to the retaining of 200,000 cubic feet.

THIS clipping, forwarded in the usual way, is reprinted for the benefit of whom it may concern: "It is rather queer, just as the Queen [of England] is having electric lights installed in the royal residences, that the Prince of Wales is having them taken out of Marlborough House and Sandringham, and return to gas illumination, with candles, of course, wherever they may be needed. Nothing [other or else] has so upset fashionable London as such a move on the part of their arbiter. Everyone is seeking the reason for it, as electric illumination has been adopted in all the great houses of the kingdom. Perhaps Wales or his wife begins to be afraid of a light which is more dazzling than the one that beats about a throne. Complexions made to order can't stand it; but, then, as there are always 'lovely' shades to subdue the glare, it cannot be that, after all." No; certainly not. The cost has, we imagine, much to do with it. Think of paying so much per carat for a stone, the brilliance of which in its uncovered estate would glare to the point that it would have to be covered! Much better would it be to select a stone the shining qualities of which were enough but not more.

A CORRESPONDENT in Washington, D. C., incloses the following clipping, from the Washington (D. C.) *Star*, of recent date: "The District Inspector of Plumbing some time ago requested the District Commissioners to inform him as to the application of the act of Congress, of June 18, 1898, to gasfitting done by the Washington Gas Light Company and other unlicensed parties. The matter was referred by the Commissioners to the Attorney for the District, who has advised them about as follows: The law in question provides that it shall be unlawful for any person to engage in the work of plumbing or gasfitting in the District unless he is licensed as provided in the act, or is an employee of a licensed master plumber. In his opinion parties who make a business of supplying gas ranges and making connections of such fixtures to the house system of gas piping, as well as to the water supply or domestic boilers, are engaged, in the language of the act, in the work of plumbing or gasfitting in the District, and, therefore, the attorney concludes, it is unlawful unless he is licensed as provided in this act, or is an employee of a licensed master plumber. As to the case of a man employed by a local firm to hang gas fixtures, the attorney says that the man, if qualified, is entitled to a license as a master gasfitter, and when so licensed he, or any of said man's employees, would be entitled to engage in the work of gasfitting in the District. To entitle any one, not himself licensed, though in the employ of the firm, to engage in the work of plumbing or gasfitting in the District, would, in the opinion of the attorney, require that the firm, or the person actually engaged in doing the work, should be licensed as required by the act in question. The opinion of their attorney has been approved by the Commissioners, and the Inspector of Plumbing will be so notified."

A Defense Association in the Machinery Trade.

On the evening of the 4th inst. the second meeting of the Metal Trades Association was held at the Waldorf-Astoria Hotel, New York. Plans for the permanent organization of the Association were perfected, and a number of manufacturers who are non-members were in attendance to have unfolded to them the plans of the organization.

It is said that this Association consists of manufacturers who employ machinists. The Association will aim to establish equitable relations between employers and their employees for the protection of both interests. In other words, it will seek to protect its members against or meet the existing unions of the employees much on the lines of the Stove Founders' Association and the National Foundrymen's Association.

William H. Pfahler, Secretary of the Abraham Cox Stove Company, of Philadelphia, delivered an address explaining the lines on which the Stove Founders' Association operated and illustrating the benefits derived from the association of the members.

The first meeting, at which the Metal Trades Association was really formed, was held at "The Arena," 31st street near Broadway, New York, on August 25. In a letter sent to the trade at that time by H. N. Covell, of the Lidgerwood Mfg. Company, and signed by H. R. Worthington, the E. W. Bliss Company and the Lidgerwood Mfg. Company, the following was embodied:

"The universal agitation now going on in labor circles would indicate that united action on the part of employers is extremely desirable, especially in view of the very satisfactory results attained by the foundry interests through their association in its dealings with the molders."

This extract indicates the purpose of the newly formed Association. We are informed that A. J. Caldwell, of the H. R. Worthington Company, is Secretary of the new Association. Among the concerns who are said to be identified with the project, besides those already mentioned, are the De La Vergne Refrigerating Machine Company and Manning, Maxwell & Moore.

THE AMERICAN GAS LIGHT JOURNAL

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AGENTS:

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MONDAY, DEC. 11, 1899.

The Market for Gas Securities.

The feature of the week in New York city gas shares was a sharp decline in New Amsterdam, common and preferred. The former this afternoon (Friday) was quoted at 24¼ to 24¾, the latter being reported at 45½ to 47½. The Company's consolidated 5's are also weaker. Consolidated also shows a decline, which is undoubtedly attributable to the generally unsettled condition of the money market, rather than to any unfavorable development in respect of the gas situation. The closing for it to-day was made at 189½ to 190½. Mu ual is 300 bid. Standards are nominally weaker. We unhesitatingly advise the purchase of the common of the latter at anything under 115.

There is no particular change in Brooklyn. Peoples, of Chicago, in sympathy with the addled state of the money market, went below 110. Lacledes are strong; the common closed to-day at 84 to 84½. Our quotation for Baltimore Consolidated is 61 to 63, showing a smart gain in the stock for the past week. Western gas rules strong, and is bound to go higher.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

DEC. 11.

☞ All communications will receive particular attention

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$39,078,000	100	189½	190½
Central Union, Bonds, 5's.	3,000,000	1,000	107½	108½
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	115	18
Metropolitan Bonds	658,000	.	108	112
Mutual	3,500,000	100	300	330
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	...	
New Amsterdam Gas Co.	13,000,000	100	24¼	24¾
Preferred	10,000,000	100	45½	47½
Bonds, 5's	11,000,000	1,000	95	97
Northern Union, Bonds, 5's.	1,250,000	1,000	95	97
New York and East River..				
Bonds 1st 5's	3,500,000	1,000	109	111
" 1st Con. 5's	1,500,000	..	112	114
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	105	120
Preferred	5,000,000	100	133	140
Bonds, 1st Mortgage, 5's	1,500,000	1,000	112	114
Yonkers	299,65	500	130	.
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	138½	139
" " Bonds (5's)	15 000,000	1,000	118	119
Bay State	50,000,000	50	1¾	1⅞
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	40	..
" 1st Mtg. 5's	475,000	1,000	96½	99½
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	92	..
2d " " "	3,000,000	1,000	68	71
Buffalo City Gas Co.	5,500,000	100	9	11
" " Bonds, 5's	5,250,000	1,000	84	85
Central, San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,207,000	1,000	106	108
Columbus (O.) Gas Lt. & Heating Co	1,682,780	100	60	65
Preferred	3,026,500	100	84	86
Consumers, Jersey City Bonds	600,000	1,000	102	105
Cincinnati G. & C. Co.	8,500,000	100	194	194½
Consumers, Toronto	1,700,000	50	230	235
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	11,000,000	100	61	63
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	21	23
" Con. Mtg. 5's	380,000	1,000	87	90
Consolidated G. & E. Co.'s, Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co.	4,560,000	50	97	98
" Prior Lien 5's	4,598,000	1,000	99½	100
Detroit Gas Co., 5's	386,000	1,000	100	101
" Inc. 5's	16,000	100	100½	101
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	77	83
" Bonds	2,000,000	..	80	85
Grand Rapids Gas Lt. Co.	1,000,000	50	..	..
" 1st Mtg. 5's	1,125,000	1,000	..	..
Hartford	750,000	25	..	220
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	102	105
Indianapolis	2,000,000	..	122	128
" Bonds, 6's	2 650,000	..	105	106
Jackson Gas Co.	250,000	50	72	73
" 1st Mtg. 5's	250,000	1,000	101	102½
Lafayette Gas Co., Ind.	1,000,000	100	68	70
Bonds	1,000,000	1,000	81	86
Louisville	2,570,000	50	106	108
Laclede, St. Louis	7,500,000	100	84	84½
Preferred	2,500,000	100	94	100
Bonds	10,000,000	1,000	107	108
Madison Gas & Elec. Co.	400,000	100	82	85
" 1st Mtg. 6's	350,000	1,000	102½	108
Montreal, Canada	2,000,000	100	200	..
Newark, N. J., Gas Co.	16,000,000	..	50	60
Bonds, 6's	4,600,000	..	107	108
New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	43	45
" Bonds	750.000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	109	109½
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	111⅜	111½x
2d "	2,500,000	1,000	104	105
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	56	58
St. Paul Gas Light Co.	1,500,000	100	57½	58½
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,428,000	1,000	88	90½
St. Joseph Gas Co.	1,000,000	100	42	44
" 1st Mtg. 5's	750,000	1,000	96½	98
Syracuse, N. Y.	1,750,000	100	15½	18
Bonds	1,612 000	1,000	81	84
Washington, D. C	2,000,000	20	285	..
First mortgage 6's	650,000	..	..	..
Western, Milwaukee	4,000,000	100	106¾	107¾
Bonds, 5's	3,880,500	.	106	108
Wilmington, Del.	600,000		220	250

Advertisers' Index.

GAS ENGINEERS.

	Page
Wm. Henry White, New York City	959
Fred. Bredel, Milwaukee, Wis.	946
Geo. R. Rowland, New York City	943
The Western Gas Construction Co., Fort Wayne, Ind.	924
Humphreys & Glasgow, New York City	944
American Gas Co., Phila., Pa.	946
David Leavitt Hough, New York City	956
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	943
Baxter & Young, Detroit, Mich.	956
United Gas Improvement Co., Phila., Pa	951
James T. Lynn, Detroit, Mich.	956
A. E. Boardman, Brevard, N. C.	956
Gilbert & Barker Mfg. Co., New York City	942

GAS WORKS APPARATUS AND CONSTRUCTION.

James R. Floyd's Sons, New York City	960
Continental Iron Works, Brooklyn, N. Y.	958
Deily & Fowler, Phila., Pa.	960
Kerr Murray Mfg. Co., Fort Wayne, Ind	956
Stacey Mfg. Co., Cincinnati, Ohio.	959
Bartlett, Hayward & Co., Baltimore, Md.	957
Davis and Farnum Mfg. Co., Waltham, Mass.	956
R. D. Wood & Co., Phila., Pa.	958
Isbell-Porter Company, New York City	958
Fred. Bredel, Milwaukee, Wis.	946
United Gas Improvement Co., Phila., Pa.	951
National Gas and Water Co., Chicago, Ills.	953
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	943
The Western Gas Construction Co., Fort Wayne, Ind.	924
Humphreys & Glasgow, New York City	944
American Gas Co., Phila., Pa.	946
Logan Iron Works, Brooklyn, N. Y.	960
Riter-Conley Mfg. Co., Pittsburgh, Pa.	959
Baxter & Young, Detroit, Mich.	956
Berlin Iron Bridge Co., East Berlin, Conn.	945
G. Shepard Page's Sons, New York City.	956
James T. Lynn, Detroit, Mich.	956
A. E. Boardman, Brevard, N. C.	956
Gilbert & Barker Mfg. Co., New York City	942
Sutherland Construction & Improvement Co., N.Y. City	942

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md.	957
United Gas Improvement Co., Phila., Pa.	951
Burdett Loomis, Hartford, Conn.	958
National Gas and Water Co., Chicago, Ills.	953
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	943
The Western Gas Construction Co., Fort Wayne, Ind.	924
Humphreys & Glasgow, New York City	944
Gilbert & Barker Mfg. Co., New York City	942
Sutherland Construction & Improvement Co., N.Y. City	942
B. E. Chollar, St. Louis, Mo.	941

SCRUBBERS AND CONDENSERS.

R. D. Wood & Co., Phila., Pa.	958
James R. Floyd's Sons, New York City	960
Continental Iron Works, Brooklyn, N. Y.	958
Logan Iron Works, Brooklyn, N. Y.	960
Riter-Conley Mfg. Co., Pittsburgh, Pa.	959

TAR AND CARBONIC ACID EXTRACTOR.

R. D. Wood & Co., Phila., Pa.	958

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich.	949
American Gas Company, Phila., Pa.	941

GAS METERS.

John J. Griffin & Co., Phila., Pa.	964
American Meter Co., New York and Philadelphia	963
Helme & McIlhenny, Phila., Pa.	963
D. McDonald & Co., Albany, N.Y.	961
Nathaniel Tufts Meter Co., Boston, Mass.	962
Maryland Meter and Mfg. Co., Baltimore, Md.	962
Metric Metal Co., Erie, Pa	963
Keystone Meter Co., Royersford, Pa.	962
Detroit Meter Company, Detroit, Mich.	963

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia	963
John J. Griffin & Co., Phila., Pa.	964
D. McDonald & Co., Albany, N. Y.	961
Helme & McIlhenny, Phila., Pa.	963
Nathaniel Tufts Meter Co., Boston, Mass.	962

GAS AND WATER PIPES.

M. J. Drummond & Co., New York City	961
R. D. Wood & Co., Phila., Pa.	958
Warren Foundry and Machine Co., New York City	961
Donaldson Iron Co., Emaus, Pa.	961

PIPE CUTTERS.

The Anderson Pipe Cutter Co., East Boston, Mass.	943

GAS MAIN STOPPERS.

Safety Gas Main Stopper Co., N. Y. City	942

FLEXIBLE JOINTS.

Campbell Mfg. Co., Stamford, Conn..... 940

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, Brooklyn, N. Y..... 968

GAS COALS.

Penn Gas Coal Co., Phila., Pa..... 955
Perkins & Co., New York City..... 954
Despard Gas Coal Co., Baltimore, Md..... 955
Westmoreland Coal Co., Phila., Pa..... 955
Berwind-White Coal Mining Co., New York and Phila... 954

CANNEL COALS.

Perkins & Co., New York City..... 954

CONVEYORS.

The Link-Belt Machinery Co., Chicago, Ills 942

GAS ENRICHERS.

Standard Oil Co., New York City..... 955
The Sun Oil Co., Pittsburgh, Pa..... 955

COKE CRUSHER.

C. M. Keller, Columbus, Ind..... 955

GAS GAUGES.

The Bristol Co., Waterbury, Conn..... 944

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City 958
Isbell-Porter Co., New York City..... 958
R. D. Wood & Co., Phila., Pa..... 958
Wm M. Crane Co., New York City..... 941

CEMENTS.

C. L. Gerould, Galesburg, Ills..... 952

RETORTS AND FIREBRICKS.

J. H. Gautier & Co., Jersey City, N. J..... 952
Adam Weber, New York City..... 952
Laclede Firebrick Mfg. Co., St. Louis, Mo..... 952
Cyrus Borgner, Phila., Pa..... 952
James Gardner, Jr., Pittsburgh, Pa..... 952
Henry Maurer & Son, New York City..... 952
Baltimore Retort and Firebrick Co., Baltimore, Md..... 952
Parker-Russell Mining and Mfg. Co., St. Louis, Mo..... 952
Brooklyn Firebrick Works, Brooklyn, N. Y..... 952

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md..... 957
Fred. Bredel, Milwaukee, Wis..... 946
J. H. Gautier & Co., Jersey City, N. J..... 952
Parker-Russell Mining and Mfg. Co., St. Louis, Mo..... 952
Adam Weber, New York City..... 952

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Co., New York City..... 958
Continental Iron Works, Brooklyn, N.Y..... 958
Logan Iron Works, Brooklyn, N. Y..... 960
R. D. Wood & Co., Phila., Pa..... 958

INCANDESCENT GAS LAMPS.

Welsbach Commercial Co., Phila., Pa..... 950

BURNERS.

C. A. Gefrorer, Phila., Pa..... 958
Wm. M. Crane Co., New York City 943
D. M. Steward Mfg. Co., Chattanooga, Tenn..... 943

LAVA GAS TIPS.

D. M. Steward Mfg. Co., Chattanooga, Tenn..... 943

STREET LAMPS.

Welsbach Street Lighting Co., New York and Phila..... 948
Thos. T. W. Miner, New York City..... 940

PURIFIERS.

Stacey Mfg. Co., Cincinnati, O..... 941

PURIFYING MATERIALS.

Connelly Iron Sponge and Governor Co., New York City 953
van Baarda & Co., Dusseldorf-on-the-Rhine..... 953

VALVES.

Ludlow Valve Manufacturing Co., Troy, N. Y. 944
Chapman Valve Manufacturing Co., Boston, Mass..... 944
R. D. Wood & Co., Phila., Pa..... 958
Continental Iron Works, Brooklyn, N. Y..... 958
The P. H. & F. M. Roots Co., Connersville, Ind..... 947
Isbell-Porter Co., New York City..... 958
The Western Gas Construction Co., Fort Wayne Ind.... 924

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind..... 947
Isbell-Porter Company, New York City..... 958
Connelly Iron Sponge and Governor Co., New York City 953

ELECTRICAL APPARATUS.

Wm. Henry White, New York City..... 959

ENGINES AND BOILERS.

The Hazelton Boiler Company, New York City..... 940

PURIFIER SCREENS.

John Cabot, New York City..... 944

GAS STOVES.

American Meter Co., New York and Philadelphia..... 949
Maryland Meter and Manufacturing Co., Baltimore, Md. 962
Keystone Meter Co., Royersford, Pa..... 962
Wm. M. Crane Co., New York City..... 941
Nathaniel Tufts Meter Co., Boston Mass..... 962
Gilbert & Barker Mfg. Co., New York City..... 942

HOT WATER HEATERS.

Wm. M. Crane Co., New York City..... 941
Gilbert & Barker Mfg. Co, New York City..... 942

GASHOLDER TANKS.

J P. Whittier, Brooklyn, N. Y..... 944

GASHOLDERS.

Bartlett, Hayward & Co., Baltimore, Md..... 957
Continental Iron Works, Brooklyn, N. Y..... 958
Deily & Fowler, Philadelphia, Pa..... 960
Davis & Farnum Mfg. Co., Waltham, Mass..... 956
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 956
Stacey Mfg. Co., Cincinnati, Ohio..... 959
R. D. Wood & Co., Philadelphia, Pa..... 958
Logan Iron Works, Brooklyn, N. Y..... 960
Riter-Conley Mfg. Co., Pittsburgh, Pa..... 959

GAS SECURITIES.

Henry Marquand & Co., New York City..... 940

ADVERTISING.

J. Howland Harding, New York City..... 940

BOOKS, ETC.

Newbigging's Handbook..... 948
Field's Analysis, 1898..... 943
Scientific Books..... 954
Digest of Gas Cases..... 955
Practical Photometry..... 952
Gas Flow Computers..... 955
Hughes' "Gas Works"..... 953
Gas Engineer's Pocket-Book..... 944
Excerpts from Reports of Gas Commissioners..... 957
Poole on Fuels..... 963
Binders..... 961
Directory of Gas Companies..... 959
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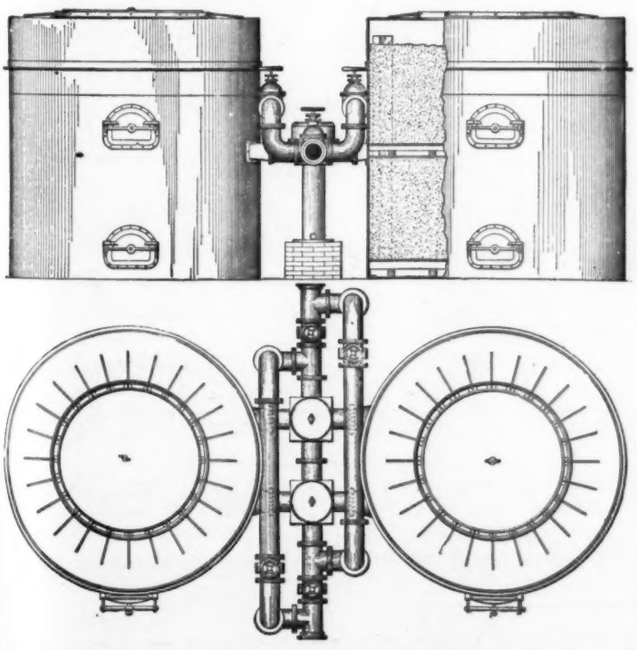

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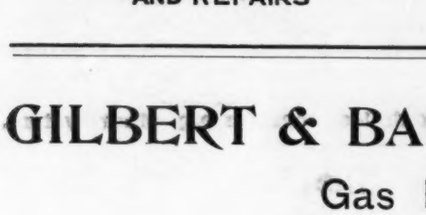

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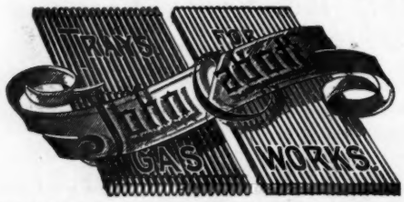

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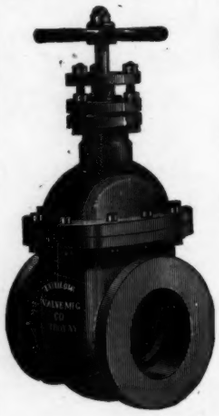

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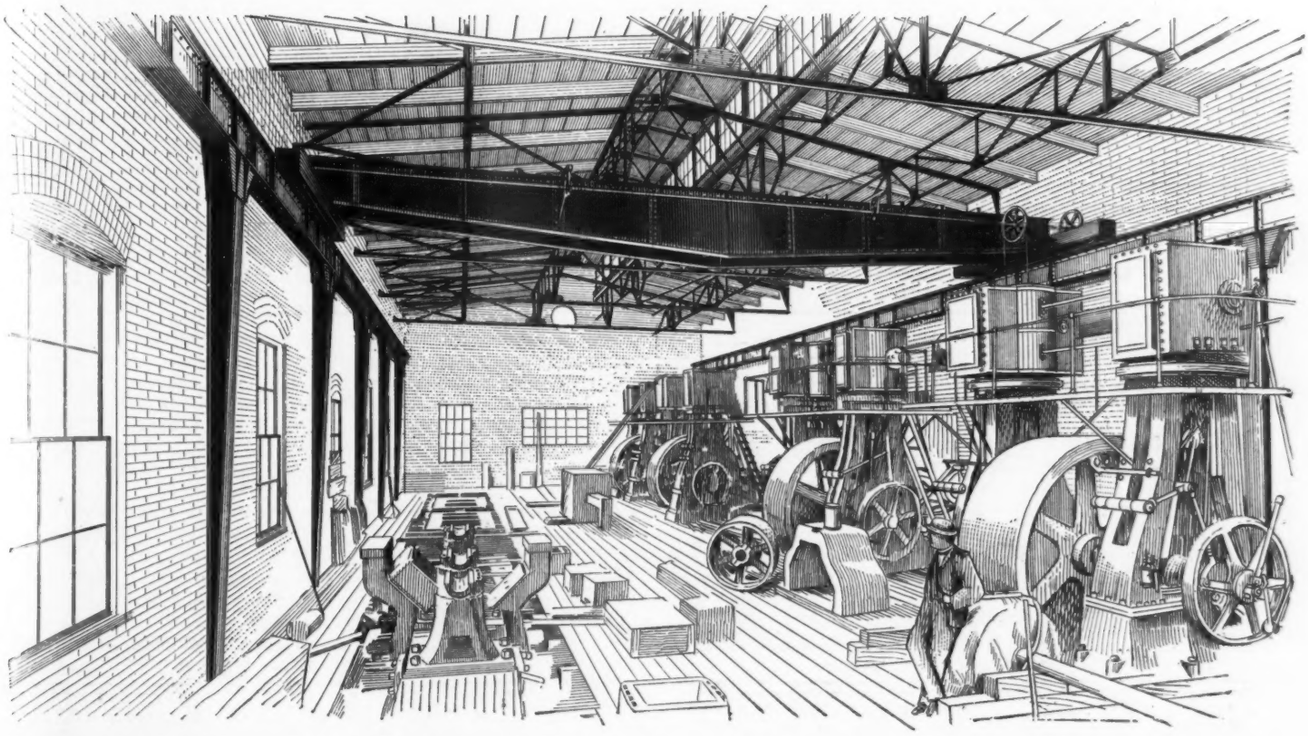

The above illustration is taken direct from a photograph and shows the interior of Power House designed and built by us for the Worcester Traction Company, at Worcester, Mass. The building is 47 feet wide and 120 feet long, with a traveling crane as shown. The roof being very flat, it is covered with plank, tar and gravel. The entire framework is of steel, a light brick wall being placed between the posts to protect the interior of the building from the weather.

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For the Year 1898.

An Analysis of the Accounts of the Principal Gas Undertakings in England, Scotland, and Ireland Being the Thirtieth Year of Publication. Compiled and Arranged by

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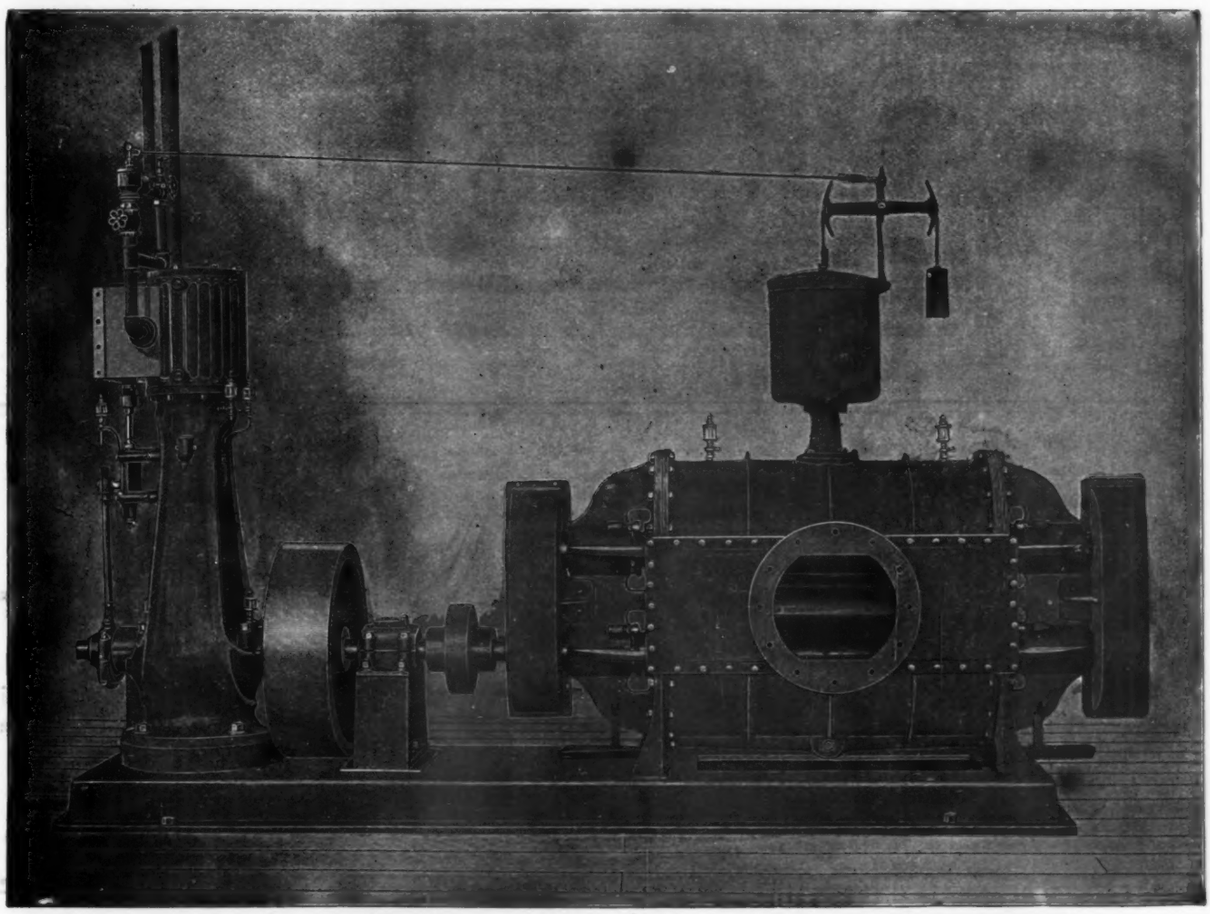

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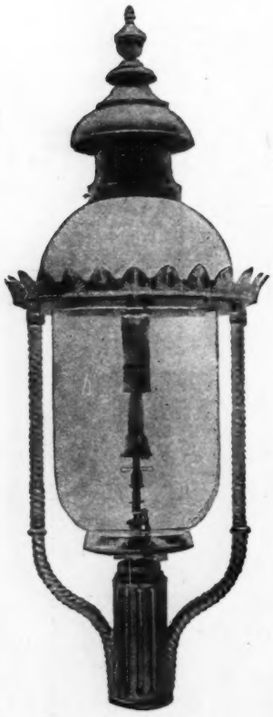

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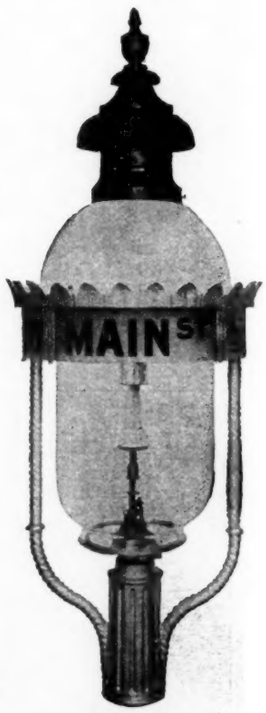

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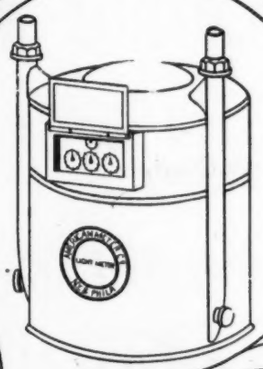

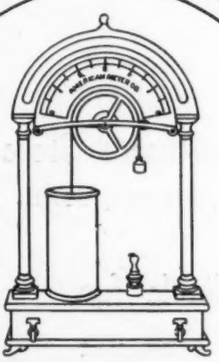

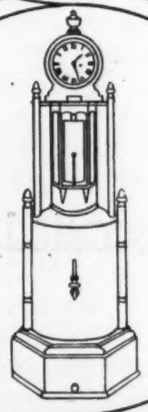

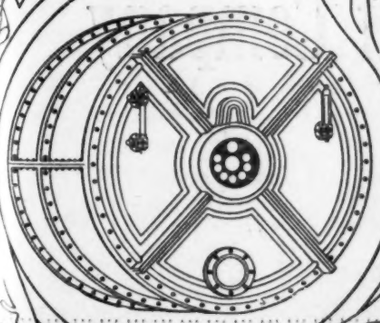

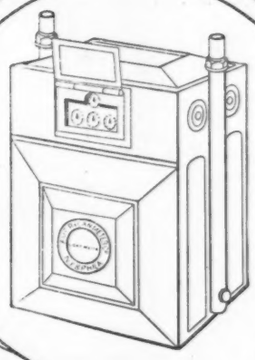

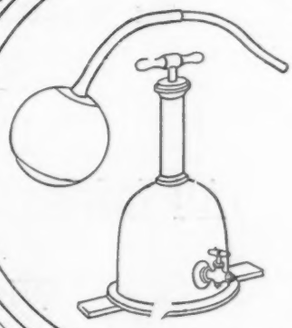

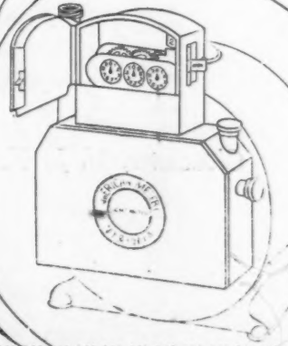

PUBLIC LIGHTING TABLE.

DECEMBER, 1899.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Fri.	1	5.10 PM	6.00 AM	4.20	6.10
Sat.	2	5.10 NM	6.00	4.20	6.10
Sun.	3	5.00	6.10	4.20	6.15
Mon.	4	5.00	6.10	4.20	6.15
Tue.	5	5.00	6.10	4.20	6.15
Wed.	6	5.00	6.10	4.20	6.15
Thu.	7	8.50	6.10	4.20	6.15
Fri.	8	10.00	6.10	4.20	6.15
Sat.	9	11.10 FQ	6.10	4.20	6.15
Sun.	10	12.20 AM	6.10	4.20	6.20
Mon.	11	1.30	6.10	4.20	6.20
Tue.	12	2.40	6.10	4.20	6.20
Wed.	13	3.50	6.10	4.20	6.20
Thu.	14	4.50	6.10	4.20	6.20
Fri.	15	No L.	No L.	4.20	6.20
Sat.	16	No L. FM	No L.	4.20	6.20
Sun.	17	No L.	No L.	4.20	6.20
Mon.	18	5.10 PM	7.20 PM	4.20	6.20
Tue.	19	5.10	8.20	4.20	6.20
Wed.	20	5.10	9.20	4.20	6.20
Thu.	21	5.10	10.20	4.20	6.20
Fri.	22	5.10	11.20	4.20	6.20
Sat.	23	5.10	12.10 AM	4.20	6.20
Sun.	24	5.10 LQ	1.10	4.20	6.25
Mon.	25	5.10	2.10	4.20	6.25
Tue.	26	5.10	3.10	4.20	6.25
Wed.	27	5.10	4.20	4.20	6.25
Thu.	28	5.10	5.20	4.20	6.25
Fri.	29	5.10	6.20	4.20	6.25
Sat.	30	5.10	6.20	4.20	6.25
Sun.	31	5.10	6.20	4.20	6.25

TOTAL HOURS LIGHTING DURING 1899.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	215.40	January	423.20
February	184.40	February	355.25
March	187.40	March	355.35
April	166.50	April	298.50
May	158.00	May	264.50
June	140.50	June	234.25
July	150 30	July	243.45
August	168.30	August	280.25
September	179.50	September	321.15
October	213.20	October	374.30
November	217.00	November	401.40
December	238.10	December	433.45
Total, yr.	2221.00	Total, yr.	3987.45

Judge Townsend, Of United States Circuit Court,

GRANTS

Welsbach Light Company

INJUNCTION AGAINST THE

Gamble-Desmond Company Department Store New Haven, Conn.

Under this decision ALL DEALERS are liable for infringements of the Welsbach Company's Rawson (coating) Patent, growing out of the act of causing the manufacture.

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	SETS.	DAILY CAPACITY.
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Derby, Conn.	1	750,000 "
Lowell, Mass.	1	1,000,000 "
Doylestown, Pa.	1	50,000 "
Darby, Pa.	1	400,000 "
Adrian, Mich.	1	125,000 "
Concord, N. H.	1	400,000 "
Sioux City, Iowa	1	750,000 "
Standard Gas Light Co., New York	3	5,400,000 "
Peekskill, N. Y.	1	250,000 "
Westchester, N. Y.	1	250,000 "
Jersey City, N. J.	1	1,000,000 "
Stapleton, N. Y.	1	750,000 "
London, O.	1	125,000 "
Chicago, Ills.	2	3,600,000 "
Putnam, Conn.	1	125,000 "
Mansfield, O.	1	250,000 "
Plymouth, Pa.	1	125,000 "
Athens, Pa.	1	125,000 "
Charlotte, N. C.	1	250,000 "
Consolidated Gas Co., New York	2	2,000,000 "
Quincy, Ills.	1	250,000 "
Boone, Ia.	1	125,000 "
Webster, Mass.	1	50,000 "
Flushing, N. Y.	1	250,000 "
Total	29	18,650,000 "
Previously built	294	187,100,000 "
Grand Total	323	205,750,000 "

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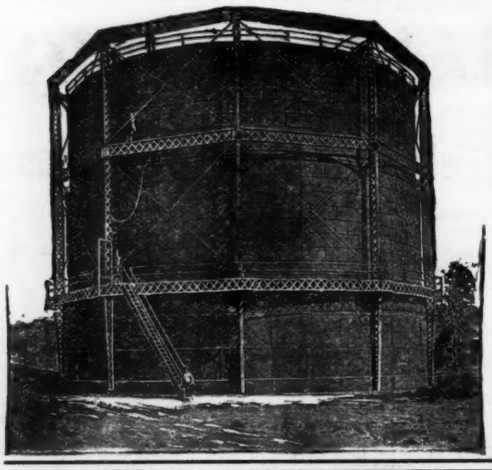

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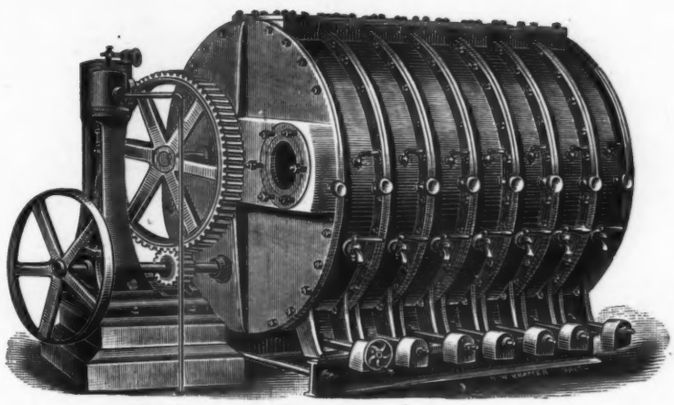

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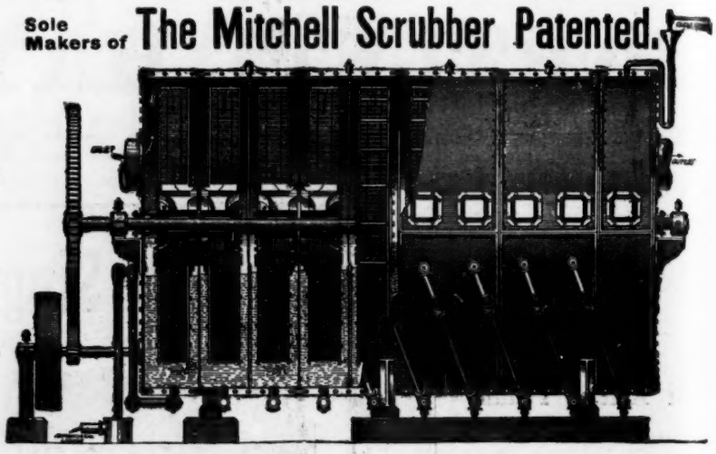

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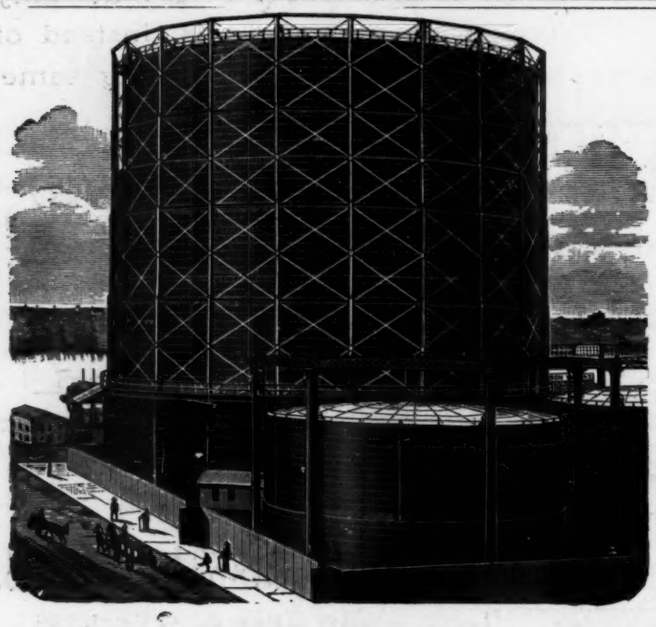

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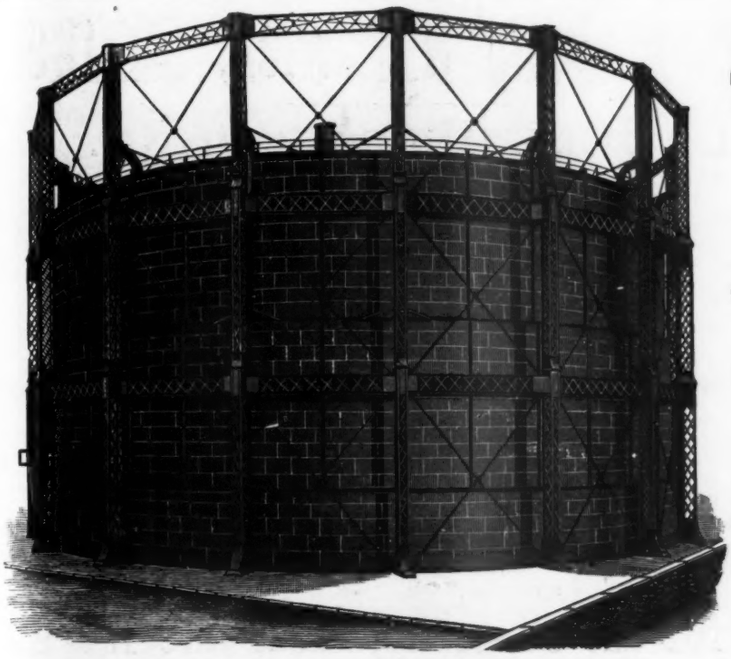

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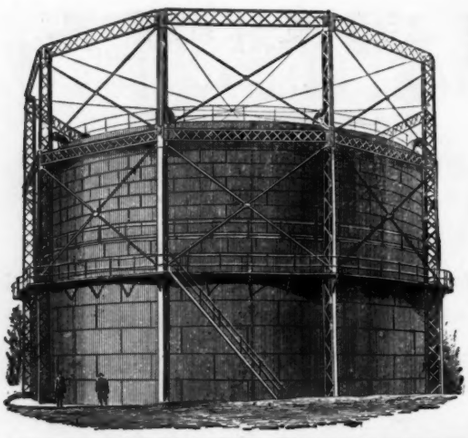

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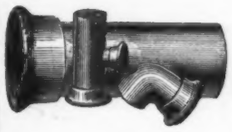

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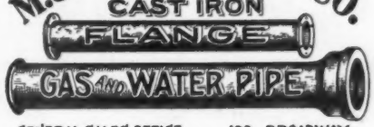

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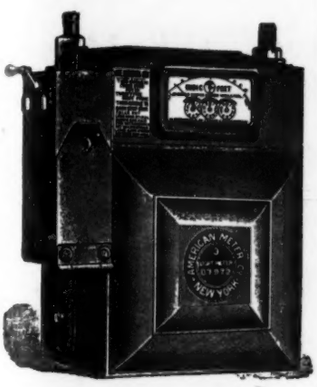

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